Repeat Radiography and Image Rejection in Digital Diagnostic Imaging: Causes, Radiation Safety Implications, Quality Assurance Strategies, and Future Directions

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Abstract : Repeat radiography remains an important quality assurance concern in diagnostic imaging despite the widespread adoption of digital radiography (DR) systems. Although digital technologies have reduced exposure-related errors, image repetition continues to contribute to unnecessary radiation exposure, increased healthcare costs, workflow inefficiencies, and delayed patient care. This review synthesises evidence from multiple studies evaluating image rejection and repeat radiography practices across different healthcare settings. The findings demonstrate that positioning errors, centring inaccuracies, patient motion, artifacts, inadequate patient preparation, and communication deficiencies are the predominant causes of image repetition. Reported repeat rates varied considerably between institutions, ranging from approximately 1.9% to 8.5%, reflecting differences in equipment, workflow, staff training, and quality assurance policies. Recent investigations indicate that human factors rather than equipment limitations account for the majority of repeat examinations. Comprehensive reject analysis programs, structured radiographer education, standardized imaging protocols, improved patient communication, and integrated PACS-based monitoring systems have shown significant potential for reducing repeat rates. This review highlights the evolving nature of image rejection in the digital era and proposes practical strategies for improving image quality while minimizing patient radiation exposure in accordance with ALARA principles.

Keywords: Digital radiography, repeat radiography, reject analysis, image quality, radiation protection, positioning error, quality assurance, ALARA.

1. Introduction

The transition from conventional film-screen radiography to computed radiography and digital radiography has revolutionized medical imaging by improving image acquisition, storage, transmission, and post-processing capabilities. Nevertheless, the challenge of repeat radiography has not been completely eliminated. Digital systems have reduced many exposure-related problems, yet image repetition remains a significant concern because repeated examinations expose patients to avoidable ionizing radiation and increase departmental workload. Studies consistently demonstrate that repeat imaging affects operational efficiency, equipment utilization, healthcare costs, and patient safety.

The primary objective of diagnostic radiography is to produce images of sufficient diagnostic quality while maintaining radiation exposure as low as reasonably achievable (ALARA). Despite advances in detector technology and image processing algorithms, image quality continues to depend heavily on operator performance, patient cooperation, and adherence to standardized imaging protocols. Consequently, reject analysis remains an essential quality management tool in modern radiology departments.

2. Evolution of Repeat Radiography in the Digital Era

Historically, repeat examinations were predominantly caused by exposure selection errors resulting from the limited exposure latitude of film-screen systems. Modern DR systems possess a wider dynamic range and can tolerate significant exposure variations without substantial degradation in image quality. As a result, the profile of rejection causes has shifted from

technical exposure issues toward human-performance-related factors.

Recent evidence demonstrates that image repetition rates remain substantial despite technological advancements. A 2025 study performed in two Iranian hospitals reported an overall repeat rate of 8.48% among 2,192 radiographic images, indicating that digital transformation alone cannot eliminate repeat imaging. Positioning and centering errors accounted for most repeated examinations.

Similarly, studies conducted in teaching hospitals and tertiary care centers continue to identify repeat radiography as a meaningful quality indicator despite relatively lower repeat rates.

3. Magnitude of Repeat Radiography

The prevalence of repeat imaging varies considerably among institutions and patient populations.

Study	Repeat Rate
Teaching hospital study (2022)	1.87%
Digital radiology study (2025)	8.48%
Computed radiography observational study	Frequent repeats across chest, spine, pelvis, extremity, and skull examinations
Other reviewed studies	Generally between 3% and 9% as reported across institutions

These variations largely reflect differences in:

- Workforce experience
- Department workload
- Equipment maintenance
- Quality assurance implementation
- Patient demographics
- Institutional imaging protocols

4. Major Causes of Repeat Radiography

4.1 Positioning Errors

Positioning error is consistently identified as the leading cause of image rejection and repetition in digital radiography.

One recent study attributed 48.92% of all repeated examinations to positioning and projection errors.

Reasons for Image Repetition	Percentage
Centring Errors	18.81
Detector Artifacts	5.91
Patient non-cooperation*	10.21
Position and projections	48.92
Wrong Exposure	8.63
Other reasons**	7.52
Total	100

*Patient non-cooperation included factors such as the presence of foreign objects, inadequate inspiration and patient movement.
**Other reasons included generators malfunctions and software errors.
Incorrect patient alignment can result in:

- Incomplete anatomical coverage
- Rotation artifacts
- Improper joint visualization
- Diagnostic uncertainty

Positioning difficulties become more pronounced in trauma patients, pediatric patients, elderly individuals, and patients with limited mobility.

4.2 Centering Errors

Centering inaccuracies represented 18.81% of repeat images in one large DR study.

Improper centering may lead to:

- Cut-off anatomy
- Suboptimal beam utilization
- Compromised anatomical visualization
- Need for additional exposures

Because centering error is directly linked to operator performance, targeted retraining programs can substantially reduce its occurrence.

4.3 Patient Motion

Patient motion remains an important contributor to image repetition.

Motion artifacts may result from:

- Poor patient cooperation
- Pain
- Anxiety
- Inadequate instructions
- Inability to maintain required positions

Motion-related blur directly reduces diagnostic confidence and frequently necessitates repeat exposure.

4.4 Foreign Objects and Inadequate Patient Preparation

Several investigations emphasize inadequate patient preparation as a major factor contributing to image rejection.

A study from India found that foreign objects constituted the largest category of repeated chest radiographs, accounting for approximately 41% of repeat examinations. Common examples included jewelry, metallic clothing components, and removable accessories.

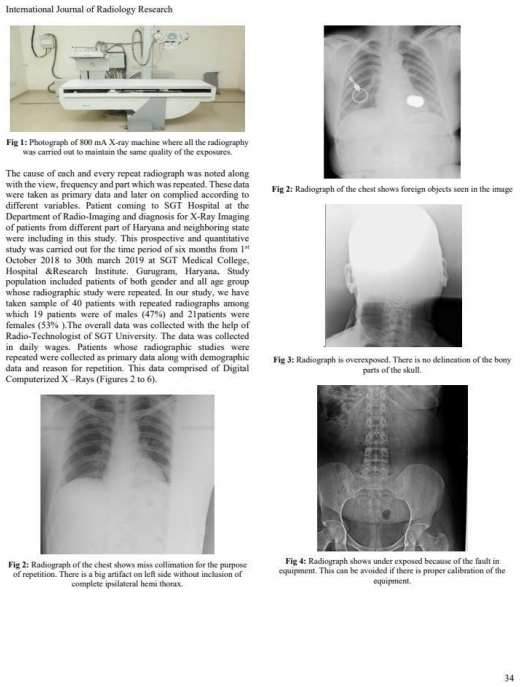

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Fig 1: Photograph of 800 mA X-ray machine where all the radiography was carried out to maintain the same quality of the exposures.

The cause of each and every repeat radiograph was noted along with the view, frequency and part which was repeated. These data were taken as primary data and later on complied according to different variables. Patient coming to SGT Hospital at the Department of Radio-Imaging and diagnosis for X-Ray Imaging of patients from different part of Haryana and neighboring state were including in this study. This prospective and quantitative study was carried out for the time period of six months from 1st October 2018 to 30th march 2019 at SGT Medical College, Hospital &Research Institute. Gurugram, Haryana. Study population included patients of both gender and all age group whose radiographic study were repeated. In our study, we have taken sample of 40 patients with repeated radiographs among which 19 patients were of males (47%) and 21patients were females (53%).The overall data was collected with the help of Radio-Technologist of SGT University. The data was collected in daily wages. Patients whose radiographic studies were repeated were collected as primary data along with demographic data and reason for repetition. This data comprised of Digital Computerized X –Rays (Figures 2 to 6).

Fig 2: Radiograph of the chest shows foreign objects seen in the image

Fig 3: Radiograph is overexposed. There is no delineation of the bony parts of the skull.

Fig 2: Radiograph of the chest shows miss collimation for the purpose of repetition. There is a big artifact on left side without inclusion of complete ipsilateral hemi thorax.

Fig 4: Radiograph shows under exposed because of the fault in equipment. This can be avoided if there is proper calibration of the equipment.

34

Source: *Jha PK, Khan AA, Rai H. Analysis of repeat radiography and corrective measures in teaching hospital in tertiary health care centre. Int J Adv Res. 2022;10(6):91-94. doi:10.21474/IJAR01/14860.*

These findings highlight the importance of thorough patient education prior to image acquisition.

4.5 Exposure Errors

Although DR systems have significantly reduced exposure-related repeats, such errors still occur.

Exposure mistakes include:

- Underexposure
- Overexposure
- Incorrect kVp selection
- Incorrect mAs selection

The 2025 DR study reported that exposure-related factors contributed to 8.63% of repeated examinations.

4.6 Equipment and Detector Issues

Equipment-related causes include:

- Detector artifacts
- Software malfunctions
- Generator failures
- Calibration problems
- Imaging plate defects

Detector artifacts accounted for nearly 6% of repeated images in recent analyses.

Regular preventive maintenance therefore remains essential.

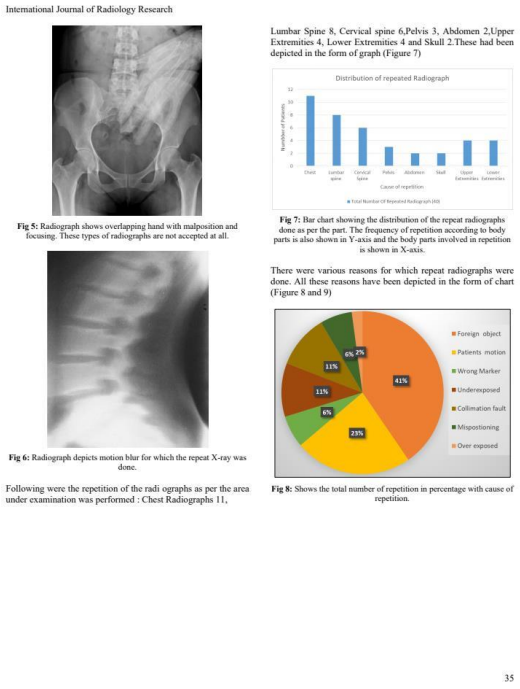
5. Anatomical Regions with Higher Repeat Rates

Certain examinations demonstrate increased susceptibility to repetition.

Studies have reported elevated repeat frequencies involving:

- Chest radiography
- Extremity imaging
- Spine examinations
- Pelvic radiography

Extremity examinations represented the largest proportion of repeated images in one digital radiography investigation.



Source: *Jha PK, Khan AA, Rai H. Analysis of repeat radiography and corrective measures in teaching hospital in tertiary health care centre. Int J Adv Res. 2022;10(6):91-94. doi:10.21474/IJAR01/14860.*

The complexity of positioning, trauma-related pain, and anatomical variability contribute substantially to these findings.

6. Human Factors and Workforce Performance

A recurring theme across the reviewed literature is the dominant role of human factors in image repetition.

Contributing factors include:

- Insufficient experience
- Heavy workload
- Time pressure
- Communication deficiencies
- Inadequate supervision of trainees
- Failure to follow established imaging protocols

Teaching hospitals may experience additional challenges due to trainee participation in image acquisition.

Many studies conclude that image repetition should no longer be viewed primarily as a technological problem but as a performance and quality management issue.

7. Radiation Protection Implications

Repeated examinations inevitably increase cumulative patient radiation exposure.

Although individual radiographic procedures usually involve low doses, repeated imaging contributes unnecessary exposure without additional diagnostic benefit. According to reviewed studies, nearly half of repeat examinations may be directly attributable to preventable positioning-related errors.

Radiographers therefore carry a professional responsibility to:

- Minimize repetition
- Optimize image quality
- Adhere to ALARA principles
- Reduce avoidable radiation burden

8. Quality Assurance and Reject Analysis Programs

Reject analysis programs are among the most effective tools for reducing repeat imaging.

These programs enable departments to:

- Monitor rejection trends
- Identify operator-specific issues
- Detect equipment failures
- Evaluate protocol effectiveness
- Design targeted educational interventions

Research consistently demonstrates that departments performing routine reject analysis achieve improved quality control and more effective radiation protection.

Modern PACS-integrated monitoring systems further facilitate automated analysis of rejection patterns and departmental performance indicators.

9. Strategies for Reducing Repeat Radiography

Based on evidence synthesized from the reviewed studies, the following interventions are recommended:

Educational Strategies

- Regular competency assessments
- Continuing professional education
- Simulation-based positioning training
- Supervised training programs

Patient-Centered Strategies

- Clear pre-examination instructions
- Removal of removable metallic objects
- Effective communication techniques
- Improved patient preparation protocols

Technical Strategies

- Routine equipment calibration
- Detector quality control testing
- Exposure protocol optimization
- Standardized examination checklists

Organizational Strategies

- Continuous reject analysis
- PACS-based monitoring systems
- Peer review mechanisms
- Quality assurance audits

10. Research Gaps

Several important gaps remain in the literature:

1. Limited multicenter studies involving diverse populations.
2. Insufficient evaluation of artificial intelligence for repeat prediction.

3. Lack of standardized international reject-analysis methodologies.
4. Limited investigation of radiographer experience as an independent predictor.
5. Inadequate assessment of cost implications of repeat imaging.
6. Few prospective studies evaluating long-term benefits of educational interventions.

Addressing these gaps could support the development of evidence-based quality improvement programs.

11. Future Directions

Future research should focus on:

- AI-assisted positioning guidance.
- Real-time reject analysis dashboards.
- Automated quality scoring systems.
- Patient-specific protocol optimization.
- National benchmarking databases.
- Integration of dose monitoring and reject analysis tools.

Emerging digital technologies may provide opportunities to reduce variability and standardize image acquisition practices across institutions.

12. Conclusion

Repeat radiography remains a significant challenge in modern diagnostic imaging despite substantial advances in digital radiography technology. The available evidence indicates that most repeat examinations result from preventable human factors, particularly positioning and centering errors. Patient motion, inadequate preparation, artifacts, and exposure-related mistakes also contribute to image rejection. Repeat imaging increases radiation exposure, healthcare costs, and workflow inefficiencies while offering little clinical benefit in many cases.

Sustainable reduction of repeat radiography requires a multifaceted strategy involving continuous professional education, standardized imaging protocols, robust quality assurance frameworks, routine reject analysis, and effective patient communication. By implementing these measures, radiology departments can improve diagnostic quality, enhance patient safety, and further advance the principles of radiation protection in contemporary healthcare**.**

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