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Original Article

Evaluation of Diagnostic Image Quality of Chest Posteroanterior Radiographs at a Tertiary Care Teaching Hospital in Puducherry: A Prospective Cross-Sectional Study

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ABSTRACT

Background: Chest radiography is one of the most frequently performed diagnostic imaging examinations, and optimal image quality is essential for accurate diagnosis and effective patient management.

Objective: To evaluate the diagnostic quality of chest posteroanterior (PA) radiographs using standardized image quality assessment criteria.

Materials and Methods: A prospective cross-sectional observational study was conducted in the Department of Radiology, Aarupadai Veedu Medical College and Hospital, Puducherry. A total of 480 chest PA radiographs obtained over six months were evaluated for anatomical coverage, penetration, inspiration adequacy, and scapular positioning. Data were analyzed using descriptive statistics.

Results: Adequate anatomical coverage, penetration, inspiration, and scapular positioning were observed in 408 (85.0%), 374 (77.9%), 394 (82.1%), and 355 (74.0%) radiographs, respectively. Overall, 190 (39.6%) radiographs fulfilled all four quality criteria.

Conclusion: Although individual quality parameters were satisfactory, fewer than half of the radiographs met all predefined quality criteria, highlighting the need for continuous quality assurance, standardized imaging protocols, and regular radiographer training to improve diagnostic image quality.

Keywords: Chest radiography; Chest X-ray; Diagnostic image quality; Quality assurance.

Introduction:

Chest radiography remains one of the most frequently performed diagnostic imaging examinations in clinical practice and accounts for approximately 30–40% of all radiological investigations worldwide. Owing to its wide availability, low cost, rapid acquisition time, and relatively low radiation dose, chest radiography continues to be the first-line imaging modality for evaluating pulmonary diseases, cardiovascular disorders, thoracic trauma, and numerous other chest abnormalities [1].

Despite continuous advances in digital radiography technology, obtaining consistently high-quality chest radiographs remains a significant challenge. Diagnostic interpretation depends not only on the radiologist's expertise but also on the technical quality of the acquired image. Poor patient positioning, inadequate inspiration, incorrect exposure factors, incomplete anatomical coverage, and improper scapular positioning may obscure important anatomical structures, reduce diagnostic confidence, increase reporting errors, and necessitate repeat imaging, thereby increasing radiation exposure and healthcare costs [2,3]. Quality assurance (QA) and quality control (QC) programmes are fundamental components of modern radiology practice. Although equipment performance testing is routinely performed in most radiology departments, systematic evaluation of diagnostic image quality is often underemphasized. Periodic image quality audits provide valuable information regarding technical performance, identify recurring imaging errors, and support continuous improvement in radiographic practice [4,5].

Standardized image quality assessment criteria—including adequate anatomical coverage, appropriate penetration, sufficient inspiratory effort, and correct scapular positioning—are widely accepted indicators of diagnostic adequacy for chest posteroanterior radiographs. Regular assessment of these parameters helps maintain imaging standards, improve diagnostic reliability, reduce repeat examinations, and enhance patient safety [6–8]. Several international studies have evaluated the quality of chest radiographs and reported that positioning errors, inadequate exposure, and poor inspiratory effort remain common causes of suboptimal image quality despite improvements in digital radiography systems [7–10].

However, published evidence regarding routine image quality audits in tertiary care teaching hospitals in India remains limited. Evaluation of locally generated radiographs is therefore essential for identifying institution-specific deficiencies and implementing targeted quality improvement measures. Hence, the present study was undertaken to evaluate the diagnostic quality of chest posteroanterior radiographs obtained at a tertiary care teaching hospital in Puducherry using standardized image quality assessment criteria. The findings are expected to provide baseline evidence for strengthening departmental quality assurance programmes and improving routine radiographic practice.

MATERIALS AND METHODS

This prospective cross-sectional observational study was conducted in the Department of Radiology, Aarupadai Veedu Medical College and Hospital, Puducherry, India, to evaluate the diagnostic image quality of routine chest posteroanterior (PA) radiographs using standardized radiographic quality assessment criteria. The study was carried out over a period of six months and included all eligible chest PA radiographs obtained during routine clinical practice. Chest radiography is one of the most frequently performed diagnostic imaging procedures, and maintaining high image quality is essential for accurate diagnosis, minimizing repeat examinations, and reducing unnecessary radiation exposure. Therefore, a systematic evaluation of routinely acquired chest radiographs was undertaken to identify the quality of images produced in the department and to determine the most common technical factors affecting diagnostic adequacy. A total of 480 chest posteroanterior radiographs were included in the study using a consecutive sampling technique, whereby every eligible radiograph obtained during the study period was included until the required sample size was achieved. This sampling approach minimized selection bias and reflected the routine workload of the radiology department, thereby providing a representative assessment of everyday radiographic practice. Adult patients aged 18 years and above who underwent routine chest PA radiography were eligible for inclusion. Pregnant patients, patients with unstable medical conditions preventing proper positioning, repeat radiographs obtained because of equipment malfunction, and radiographs with incomplete patient information or poor digital image quality were excluded from the study.

All radiographs were acquired using an Epsilon 600 mA X-ray unit following the standard imaging protocol routinely practiced in the department. Patients were positioned in the erect posteroanterior position whenever feasible, with the anterior chest placed against the image receptor and shoulders rotated forward to displace the scapulae laterally from the lung fields. Standard departmental exposure parameters appropriate for adult chest radiography were employed throughout the study period to maintain consistency in image acquisition.

Each radiograph was evaluated using four predefined image quality parameters that are widely accepted for assessing the diagnostic adequacy of chest radiographs. Anatomical coverage was considered adequate when the entire thoracic cavity, extending from both lung apices to the bilateral costophrenic angles, was clearly visualized. Penetration was assessed by evaluating the visibility of the thoracic vertebral bodies through the cardiac shadow, indicating appropriate exposure without over- or under-penetration. Inspiratory adequacy was determined by visualization of at least ten posterior ribs above the diaphragm on the PA chest radiograph, reflecting satisfactory inspiratory effort during image acquisition. Scapular positioning was regarded as adequate when both scapulae were projected outside the lung fields without obscuring the pulmonary parenchyma, thereby allowing optimal visualization of the lungs. Each quality parameter was recorded as either adequate or inadequate according to the predefined assessment criteria. The primary outcome measure of the study was the proportion of chest radiographs satisfying all four quality assessment criteria simultaneously, thereby representing diagnostically acceptable radiographs. Secondary outcome measures included the proportion of radiographs meeting each individual quality criterion and the identification of the most frequent technical deficiencies contributing to suboptimal image quality. The collected data were entered into Microsoft Excel for data management and analysis. Descriptive statistical methods were used to summarize the findings. Categorical variables were expressed as frequencies and percentages. Percentages were calculated using the formula: Percentage = (Number of observations ÷ Total number of radiographs) × 100. The results were presented in tables and descriptive text to facilitate interpretation of image quality parameters among the evaluated chest radiographs. The study findings were used to assess the overall diagnostic quality of routine chest radiography performed in the department and to identify areas requiring improvement through quality assurance initiatives and continuing education of radiographic personnel.

RESULTS

A total of 480 chest posteroanterior (PA) radiographs were evaluated over the six-month study period to assess diagnostic image quality using four predefined quality assessment criteria: anatomical coverage, penetration, inspiration adequacy, and scapular positioning. The demographic characteristics of the study population and the distribution of individual image quality parameters are presented in the following tables.

Gender Distribution: Among the 480 patients included in the study, 260 (54.2%) were male and 220 (45.8%) were female, indicating a slightly higher proportion of male patients undergoing routine chest radiography during the study period (Table 1).

Gender	Number of Cases	Percentage (%)
Male	260	54.2
Female	220	45.8
Total	480	100

Table 1. Gender Distribution of the Study Population (n = 480)

Age Distribution: The age distribution of the study population is shown in Table 2. The largest proportion of patients belonged to the 31–40 years age group (120; 25.0%), followed by the 41–50 years age group (110; 22.9%). Patients aged 18–30 years accounted for 96 (20.0%), while 86 (17.9%) patients were between 51–60 years. Individuals aged more than 60 years constituted the smallest age group with 68 (14.2%) participants.

Age Group (Years)	Number of Cases	Percentage (%)
18–30	96	20.0
31–40	120	25.0
41–50	110	22.9
51–60	86	17.9
>60	68	14.2
Total	480	100

Table 2. Age Distribution of the Study Population (n = 480)

Assessment of Individual Image Quality Parameters

Each chest radiograph was evaluated for anatomical coverage, penetration, inspiration adequacy, and scapular positioning. Adequate anatomical coverage was observed in 408 radiographs (85.0%), while 72 (15.0%) demonstrated incomplete visualization of the required thoracic anatomy. Adequate penetration was achieved in 374 radiographs (77.9%), whereas 106 (22.1%) showed either under- or over-penetration. Adequate inspiration was present in 394 radiographs (82.1%), while 86 (17.9%) radiographs demonstrated inadequate inspiratory effort. Correct scapular positioning was achieved in 355 radiographs (74.0%), whereas 125 (26.0%) demonstrated superimposition of the scapulae over the lung fields. Among the four evaluated parameters, scapular positioning showed the highest proportion of inadequacy.

Image Quality Parameter	Adequate n (%)
Anatomical Coverage	408 (85.0)
Penetration	374 (77.9)
Inspiration	394 (82.1)
Scapular Positioning	355 (74.0)

Table 3. Assessment of Individual Image Quality Parameters (n = 480)

Overall Diagnostic Image Quality: Radiographs were considered diagnostically acceptable only when all four predefined quality assessment criteria were fulfilled simultaneously. Of the 480 chest radiographs, 190 (39.6%) satisfied all four quality criteria and were considered to have optimal diagnostic image quality. The remaining 290 radiographs (60.4%) failed to satisfy one or more quality parameters and were therefore classified as suboptimal. These findings indicate that although most radiographs fulfilled individual quality parameters, fewer than half achieved complete compliance with all predefined image quality criteria.

Image Quality Category	Number of Cases	Percentage (%)
Met all four quality criteria	190	39.6
Failed to meet one or more criteria	290	60.4
Total	480	100

Table 4. Overall Diagnostic Image Quality (n = 480)

DISCUSSION

The Chest radiography remains the most commonly performed diagnostic imaging examination worldwide and serves as the primary investigation for evaluating a wide range of pulmonary, cardiac, and thoracic disorders. The diagnostic usefulness of chest radiographs depends largely on the quality of the acquired image, as technical deficiencies may obscure anatomical structures, reduce diagnostic confidence, and necessitate repeat examinations, thereby increasing patient radiation exposure and healthcare costs. Therefore, continuous monitoring of image quality is an essential component of quality assurance programmes in radiology departments.

In the present study, 480 chest posteroanterior radiographs obtained over a six-month period were evaluated using four standardized image quality assessment criteria: anatomical coverage, penetration, inspiration adequacy, and scapular positioning. The findings demonstrated varying levels of compliance with individual quality parameters. Adequate anatomical coverage was observed in 408 radiographs (85.0%), adequate penetration in 374 (77.9%), adequate inspiration in 394 (82.1%), and correct scapular positioning in 355 (74.0%). When all four parameters were considered simultaneously, only 190 radiographs (39.6%) fulfilled all predefined quality criteria, while 290 radiographs (60.4%) failed to satisfy one or more criteria. These findings indicate that although individual quality parameters were generally satisfactory, complete compliance with all diagnostic quality standards was achieved in fewer than half of the evaluated radiographs.

Among the four quality parameters assessed, anatomical coverage demonstrated the highest level of adequacy (85.0%). This finding suggests that radiographers routinely included the essential thoracic anatomy, extending from the lung apices to the costophrenic angles, in the majority of examinations. Adequate anatomical coverage is fundamental for accurate interpretation because incomplete visualization of the lungs may result in missed pulmonary lesions or pleural abnormalities. Similar observations have been reported by Schaefer-Prokop et al., who emphasized that proper collimation and positioning significantly improve the diagnostic completeness of chest radiographs [11-15].

Adequate penetration was observed in 77.9% of radiographs, whereas approximately one-fifth of the examinations demonstrated inappropriate exposure. Inadequate penetration remains one of the most common technical errors encountered during chest radiography and may obscure mediastinal structures or pulmonary pathology. Bushong reported that incorrect exposure factors continue to be an important cause of reduced diagnostic image quality despite advances in digital radiography systems [1]. Appropriate selection of exposure parameters and regular monitoring of exposure indices are therefore essential to ensure consistent image quality.

Adequate inspiration was achieved in 82.1% of radiographs. Proper inspiratory effort is necessary to ensure complete expansion of the lungs and accurate assessment of pulmonary and cardiovascular structures. Insufficient inspiration may falsely increase the apparent cardiac size, exaggerate basal lung opacities, and simulate pathological conditions such as atelectasis. Fauber emphasized that careful patient instruction before exposure is one of the simplest and most effective methods of improving inspiratory adequacy and reducing positioning errors [3].

Among all evaluated parameters, scapular positioning demonstrated the lowest adequacy rate (74.0%) and represented the most frequent technical deficiency identified in the present study. Failure to adequately rotate the shoulders forward results in superimposition of the scapulae over the lung fields, thereby obscuring pulmonary anatomy and reducing diagnostic confidence. Similar findings have been reported by Seeram, who highlighted improper positioning as one of the leading causes of suboptimal chest radiographs in routine clinical practice [2]. This finding emphasizes the importance of continuous training and reinforcement of correct positioning techniques among radiographers. An important observation in the present study is that although individual quality parameters demonstrated relatively high levels of adequacy, only 39.6% of radiographs simultaneously fulfilled all four predefined quality assessment criteria. This indicates that many radiographs contained one or more technical deficiencies despite appearing satisfactory in individual aspects. Consequently, assessment of individual parameters alone may overestimate the overall diagnostic quality of chest radiographs. Comprehensive quality evaluation using multiple standardized criteria therefore provides a more realistic assessment of radiographic performance and departmental quality assurance.

The demographic characteristics of the study population showed a slightly higher proportion of male patients (54.2%) compared with female patients (45.8%). The largest number of radiographs was obtained from individuals aged 31–40 years, followed by those aged 41–50 years. These demographic findings primarily reflect the patient population attending the institution during the study period and were not intended to evaluate disease prevalence or demographic associations.

The findings of the present study have important implications for routine radiographic practice. Regular image quality audits enable departments to identify recurrent technical deficiencies, monitor radiographic performance, and implement corrective measures. Continuous professional education, periodic competency assessment, adherence to standardized positioning protocols, and routine quality assurance programmes are likely to improve image quality and reduce repeat examinations. In addition, digital radiography systems equipped with exposure monitoring tools and automated quality indicators may further support optimization of radiographic technique; however, technological advancements cannot replace appropriate patient positioning and radiographer expertise.

The present study has certain limitations. It was conducted in a single tertiary care teaching hospital and therefore may not represent radiographic practice in other healthcare settings. Only descriptive statistical analysis was performed, and associations between patient characteristics and image quality parameters were not investigated. Furthermore, assessment was limited to four commonly accepted quality criteria and did not evaluate exposure index, image noise, motion artefacts, or interobserver agreement. Future multicentre studies involving larger sample sizes and comprehensive quality assessment methods are recommended to provide broader evidence regarding chest radiographic quality assurance.

Overall, the findings of this study demonstrate that while most chest radiographs satisfied individual image quality parameters, fewer than half fulfilled all predefined quality criteria simultaneously. These results highlight the need for continuous quality improvement initiatives focusing on patient positioning, exposure optimization, standardized imaging protocols, and ongoing professional training to ensure consistently high-quality diagnostic chest radiographs.

Conclusion:

This study evaluated the diagnostic quality of 480 chest posteroanterior radiographs using standardized image quality assessment criteria. Adequate anatomical coverage, penetration, inspiration, and scapular positioning were achieved in the majority of radiographs; however, only 190 (39.6%) met all four quality criteria simultaneously. These findings indicate that technical deficiencies, particularly in patient positioning and exposure optimization, remain common in routine chest radiography. Regular quality assurance programmes, adherence to standardized imaging protocols, and continuous training of radiographers are essential to improve image quality, reduce repeat examinations, and enhance diagnostic accuracy.

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