

Evaluation of the Diagnostic Quality of Chest Radiographs

Suwal S¹, Koirala S², Chataut D¹

¹Assistant Professor, Department of Radiology and Imaging, ² Student, BSc MIT Tribhuvan University Teaching Hospital, Institute of Medicine, Maharajgunj, Kathmandu, Nepal

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ABSTRACT

Introduction:

With the advancement of conventional radiography to digital, digital radiography of the chest is commonly performed these days. The role and importance of diagnostic quality of radiographs are to help the radiologists and the clinicians in the diagnosis of diseases and their management, as well as to prevent the misdiagnosis of any pathology. This study was an attempt to quantify the diagnostic quality of chest radiographs by evaluating the quality of depiction of the anatomical details as well as other technical factors.

Method:

A total of 450 chest radiographs, produced at Tribhuvan University Teaching Hospital, were selected for study over two months period. Five image quality criteria i.e. anatomical coverage, rotation, adequate penetration, adequate inspiration, and scapula out of lung fields were evaluated and tabulated.

Results:

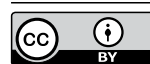
Out of the 450 radiographs taken for study, only 22.2% of the radiographs fulfilled all the image quality criteria, the rest 77.8% either lacked one or more of the quality criteria.

Conclusion:

Many technical factors affect the image quality of digital chest radiographs. However, the radiographer/technologist should always try to maintain adequate image quality of the radiographs.

Keywords: *Diagnostic Errors; Radiography; X-Rays*

Correspondence to: Dr. Dinesh Chataut,
Department of Radiology and Imaging,
Tribhuvan University Teaching Hospital,
Maharajgunj, Kathmandu
Email: dineshchataut@hotmail.com



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INTRODUCTION

Chest radiography has so far remained the most often performed study in radiology departments, accounting for about 40% of all imaging procedures, even with the advent of numerous new imaging techniques.^{1,2} Despite the simplicity of the procedure, it remains a challenge for the department to produce chest radiographs having high diagnostic accuracy.¹ Nevertheless, the fact that pathologies often remain misdiagnosed due to the poor diagnostic quality of radiographs cannot be neglected.³ The role and importance of the quality of radiographs are to help the radiologists and the clinicians in the diagnosis of diseases and their management.⁴ about 115 pelvis radiographs were selected over two months period. Eight image quality criteria i.e. anatomical coverage, sharp bony detail, rotation, collimation, artifact, beam centering, SI joint visibility and gonad protection were included. Results: Out of the 115 radiographs, only about 13% fulfilled all the image quality criteria, the rest 87% lacked either one or more of the criteria. Conclusions: To a great extent the quality of the pelvic radiographs depends on the skill of radiographer, equipment condition (x-ray machine, CR reader

To maintain adequate image quality comparable throughout the world and to improve the accuracy of results, image criteria have been presented for a particular type of radiograph by the 'European Guidelines on Quality Criteria for Diagnostic Radiographic Images'.⁵ The European guideline provides guidelines on three important aspects of imaging. The interplay of these aspects is necessary for the optimal use of X-rays and to produce an image of standard quality.

With the advancement in technology, digital radiography (DR) has almost replaced conventional radiography. Today medical imaging is complemented by multiple forms of DR and these DR modalities are increasingly in use.⁶

As the need-based frequency of chest radiographs in any radiology department is very high, it is very important to maintain an adequate diagnostic quality of regularly-produced chest radiographs. The study therefore aimed at evaluating the diagnostic quality of Chest-PA radiographs produced at TUTH, Kathmandu, Nepal.

METHODS

This was a hospital-based cross-sectional and descriptive study, conducted in the Department of Radiology of Tribhuvan University Teaching Hospital from February to March 2021.

Four hundred and fifty chest radiographs were collected and evaluated. The X-rays were performed on DR X-ray Machine by Hitachi Medical Corporation (Max. Tube voltage 150kv /1.5mm Al filtration) using Digital Radiography Image Receptor (AGFA Company).

The quality of all the collected radiographs were evaluated under five criteria as per the 'European Guidelines on Quality Criteria for Diagnostic Radiographic Images': anatomical coverage, rotation, adequate penetration, adequate inspiration, and scapula out of lung fields. Each criterion was classified into yes and no categories. The data were collected in Microsoft Excel and analyzed using SPSS program version 20.

RESULTS

A total of 450 chest radiographs of 255 females and 195 males with an age range of 9 to 92 years, and a median age of 40 years with an interquartile range of 28, were evaluated. Maximal radiographs were for the age group 21-40 years, and the least radiographs were for the age group >80 years.

The criteria of anatomic coverage in the chest radiographs were met in 97.6% and the criteria of adequate penetration were met in 82%. However, only 55.56% of the chest radiographs were not rotated. All the quality criteria of chest radiographs were met by 22.2% only. (Table 1)

Table 1: Adequacy of the image quality criteria for chest radiographs (n=450)

	Yes	No
Adequate anatomic coverage	439 (97.56%)	11
Rotation	200 (44.44%)	250
Adequate Penetration	369 (82%)	81
Adequate Inspiration	418 (92.89%)	32
Scapula out of lung fields	260 (57.78%)	190
Meet all quality criteria	100 (22.22%)	350

Adequate anatomic coverage was more in females (98.8%) as compared to the male (95.9%) with a statistically significant association of sex with the anatomic coverage (p= 0.046) and phi coefficient (ϕ) of 0.094. Optimal positioning of the scapula was also more in females (48.2%) as compared to males (34.4%) with a statistically significant association

between the sex and the scapula positioning (p =0.003), and phi coefficient (ϕ) of 0.139. There was no statistically significant association of sex with other variables of the quality measurement, although adequacy of all the variables was more in females as compared to males. (Table 2)

Table 2: Sex-wise adequacy of the image quality criteria for chest radiographs (n=450)

	Anatomic coverage		Rotation		Adequate penetration		Adequate inspiration		Scapula out of lung fields	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Female	252	3	110	145	47	208	20	235	123	132
Male	187	8	90	105	34	161	13	182	67	128

Table 3: Age-wise adequacy of the image quality criteria for chest radiographs (n=450)

	Anatomic coverage		Rotation		Adequate penetration		Adequate inspiration		Scapula out of lung fields	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
1-20	47	0	17	30	45	3	46	1	32	15
21-40	179	5	86	98	160	24	176	8	103	81
41-60	149	4	69	84	118	35	140	13	91	62
61-80	60	2	26	36	42	20	52	10	33	29
Above 80	4	0	2	2	3	1	4	0	1	3
Total	439	11	200	250	368	83	418	32	260	190

Adequacy of all the variables of image quality of chest radiographs was more in the younger age group with the statistically significant association of age with adequate penetration (p<0.001, ϕ = 0.216) and adequate inspiration (p= 0.015, ϕ = 0.165). (Table 3)

DISCUSSION

For a chest radiograph to have high diagnostic quality, there are certain criteria given by the

‘European Guidelines for Diagnostic Imaging’. The criteria to be fulfilled by the radiograph are Anatomic Coverage, No rotation, Adequate Penetration, Adequate Inspiration, and Scapula out of Lung Fields. Chest radiographs that meet all these criteria are the ones with high diagnostic quality as they provide accurate diagnosis and justify the need for examination.⁵

In this study, all the quality criteria as given by ‘European Guidelines on Quality Criteria for

Radiographic Images' were met by 22.2% only. The least met quality criteria were rotation (55.56%) and scapula out of lung fields (57.78%). Inadequacy of these two criteria was significantly less in a similar study conducted by Chand et al. in 2012. However, the adequacy of the rest of the quality criteria is more in the current study as compared to the findings of Chand et al.⁷ Improved adequacy of technical factors could be due to improvement/ advancement in imaging technology (Computed radiography versus Direct Digital radiography).

In Direct Digital Radiography, the use of a single image receptor, whose size is sufficient to include the chest anatomy of patients with all types of body habitus, is practised. Under-exposure was often the cause of inadequate penetration of X-rays in the CR system, whereas, in Direct Digital Radiography, optimum exposure factors are pre-set which rarely cause the underexposure of films.⁶

The decline in the percentage of radiographs with inadequate inspiration may be due to the improvement in communication between the radiographer and patient which increases the clarity of instructions to the patient. Proper communication with the patient is a basic and essential factor of a good radiographic technique. However, reduced fulfilment of two criteria - No rotation and Scapula out of Lung Fields indicates that the factors related to patient positioning need improvisation.

Okeji et al. also found similar results as the present study.² However, the adequacy of the two main criteria responsible for the reduced image quality of chest radiographs was, even more, less in the study findings of Okeji et al. and Abubakar et al.⁸ They found difficulty in the positioning of the pediatric and geriatric population, which contributed to the reduced adequacy of the quality criteria.^{2, 8} In the present study, only 17 pediatric patients were included and only four geriatric patients were included. Even in pediatric patients least age was nine years and most were of age 15 years or more. This might be the reason for improved quality related to positioning in our study. The current study even showed a statistically significant association of age with the scapula out of lung fields. The overall image quality of chest radiographs was poor

in the study done by Abubakar et al. as compared to the present study.⁸ All the parameters, except the adequate positioning of scapula out of the lung fields, were less in their study as compared to the present study.

The image quality of chest radiographs was better in females than in males in the present study, with a significant association of sex with anatomic coverage and scapula out of the lung fields. No such data on the association of sex with the image quality of chest radiographs were available in the literature.

Radiographic images of poor diagnostic quality result in repeats and hence more radiation dose to the patients and economic loss to the hospital. The overall quality of chest radiographs was met in only 22.22% of the chest radiographs, similar to in a study done by Okeji et al. and Abubakar et al., which is alarming.^{2,8} This indicates the need for improvisation of the techniques of obtaining chest radiographs. Regular supervision of the quality of chest radiographs along with refresher training of the radiographer's periodic audit of radiographs is an important step in patients' dose reduction, improvement of image quality, proper diagnosis of disease, and reduction in economic losses occasioned by the rejected film.

CONCLUSION

Obtaining chest radiographs that meet all the criteria of proper quality remains challenging for radiographers and technologists despite the simplicity of the procedure. We found that only 22.2% of the radiographs were satisfactory in terms of all aspects. Patient positioning was found to be the major contributor to the decreased image quality. Thus, it becomes the responsibility of radiographers to put forward the steps towards improving image quality, as far as possible, increasing the diagnostic accuracy of radiographs and promoting better patient care.

CONFLICT OF INTEREST

None

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None

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