Original Article

The Diagnostic Performance and Utility of Chest XR in Relation to Chest CT in Nontraumatic Respiratory Emergency Patients

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Abstract

Background and Aim: This study aimed to determine the diagnostic performance and utility of chest radiography in relation to chest computed tomography (CT) in nontraumatic respiratory emergency patients. **Patients and Methods:** Patients presenting to the emergency department with respiratory complaints due to nontraumatic pathologies and who had consecutive chest XR and chest CT assessments with an interval of fewer than 6 hours were enrolled in the study (n = 561). **Results:** The two methods were determined to be consistent with moderate agreement in detecting pleural effusion ($\kappa = 0.576$, $P < 0.001$), pneumothorax ($\kappa = 0.567$, $P < 0.001$), increased cardiothoracic ratio ($\kappa = 0.472$, $P < 0.001$), and pneumonic consolidation ($\kappa = 0.465$, $P < 0.001$). The consistency rate was significantly higher in patients aged <40 years (95.5% in ≤30 years and 90.9% in 31–40 years) as compared to older patients (81.8%, 68.2%, and 72.7% in 41–60 years, 61–80 years, and >80 years, respectively; $P < 0.001$ for each). The consistency rate was also higher for posteroanterior (PA) chest XR views than for anteroposterior (AP) chest XR views (72.7% vs. 68.2%, $P = 0.005$) and for high- and moderate-quality chest XR views than for poor-quality views (72.7% and 77.3% vs. 70.5%, $P = 0.001$). **Conclusion:** The consistency between the chest XR and CT was more likely in patients aged <40 years and for PA and moderate-to-high quality chest XR views, as compared to older patients and AP and poor-quality views, respectively. We suggest that an upright position PA chest X-ray with high imaging quality may be the first choice, especially in patients aged <40 years admitted to the emergency department with respiratory symptoms.

Keywords: *Computed tomography, consistency, emergency medicine, nontraumatic, radiography, respiratory pathology*

Introduction

Laboratory imaging and radiological imaging are considered to be the highest cost items in emergency care delivery comprising more than 40% of the overall cost.[1] Together with increased admission rates, the need for reasonable implementation of laboratory and radiological investigations is emphasized in conjunction with the selection of the most useful methods in diagnostic workup in emergency care settings.[1]

Respiratory symptoms such as cough, atypical chest pain, and shortness of breath are considered to be some of the most common reasons for emergency admissions.[2,3] Chest radiography is the first choice imaging modality in respiratory pathologies, and being simple and low cost, it offers extensive information in the differential diagnosis of several conditions.[4,5] However, there has been a remarkable increase in the use of chest computed tomography (CT) scans in the emergency care of patients due to both recent technical advances that enable the rapid acquisition of images together with a wealth of clear and specific information, as well as wide

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availability of CT in emergency settings.[4,6,7] However, CT is a high-cost imaging modality associated with the risk of increased exposure to ionizing radiation, emphasizing careful consideration of indications for CT in emergency care diagnoses.[6,8]

Although chest CT is considered a more favorable imaging modality than chest XR in the diagnosis of traumatic respiratory pathologies and in preoperative assessment,[6,9] it remains unclear whether the same is true for nontraumatic respiratory emergencies.[7]

This retrospective study was therefore designed to evaluate the diagnostic performance of chest radiography in relation to chest CT in nontraumatic respiratory emergency patients and to determine whether or not chest CT after chest radiography provides additional benefits in the diagnostic workup.

Materials and Methods

Study population

The Clinical Research Ethics Committee approval was received from the local ethics committee of our hospital for the study. Pregnant patients, patients with traumatic pathology, patients with more than a 6-hour interval between chest XR and chest CT, and those whose imaging findings were unavailable in the hospital database were excluded from the study. Patients of the study were selected from triage complaints who underwent emergency admission for respiratory symptoms due to nontraumatic pathologies. They had consecutive chest XR and chest CT assessment with an interval of less than 6 hours and were included in this single-center retrospective study conducted at a tertiary care emergency clinic. Adult (>18 years of age) patients, who underwent emergency admission for respiratory symptoms (e.g., cough, shortness of breath, and chest pain) due to nontraumatic pathologies (e.g., chronic obstructive pulmonary disease (COPD) and chronic heart failure) and who had chest XR, followed within 6 hours by chest CT imaging, were included in this study. This 6-hour cutoff, in which a patient would likely benefit from a therapeutic intervention and a clinical difference would alter imaging, was used in the previous study.[10]

Study parameters

Data on patient demographics (age and gender) and the type (anteroposterior (AP) and posteroanterior (PA) views) and quality (poor, moderate, and high) of chest XR, including findings and diagnoses obtained via chest XR and chest CT, were recorded. The sensitivity, specificity, and negative and positive predictive values of chest XR in the identification of chest CT-based findings were determined. The consistency between chest XR and chest CT findings was analyzed based on Cohen's kappa coefficient (κ) values with 95% confidence intervals. The consistency rate for findings and the presence of diagnostic consistency between methods were also analyzed with respect to patient demographics and the type and quality of chest XR.

Emergency care characteristics

Our hospital and emergency department serve on average between 180,000 and 200,000 patients per year, respectively. The emergency department is a tertiary care center with a 688-bed capacity that remains open for 24 hours every day.

Imaging analysis

Chest X-rays (XR) were taken using the PA technique in the upright position or using the AP technique in a supine position using a portable machine (Usx-Rad X3C, Usx-Ray, Bolu, Turkey). CT imaging was performed using a multi-detector CT scanner (Aquilion 64 CT scanner, Toshiba Medical Systems, Otawara-shi, Japan) without intravenous or oral contrast. The acquisition parameters for 64-slice CT were set to 120 kVp, 200 mA, and 5 mm slice thickness.

Chest XR imaging was evaluated by a radiologist, who was blinded to study protocol or chest CT findings of the patients—for adequacy of technique and dosage based on seven criteria including 1) complete appearance of the thorax; 2) lack of clothing, jewelry, or other objects in the plane; 3) equal distance of T3 spinous processes from each sternoclavicular joint; 4) scapula being out of lungs' field; 5) detectable vascular shadows in the peripheral lung; 6) visibility of thoracic vertebrae and large vessels of basal lung lobes behind the heart; and 7) visibility of 8–10th ribs in the posterior and 5–6th ribs in the anterior above the diaphragmatic cone in sufficient inspiration. Each criterion was given a score of 1, and chest XRs were classified according to image quality into three groups: poor-quality group (met three of the seven criteria), moderate-quality group (met four to five of the seven criteria), and high-quality group (met six to seven of the seven criteria) images.[7,11,12] Chest CT findings were retrieved from hospital official reports evaluated by another radiologist, who was blinded to the chest XR findings of the patients.

A comparative analysis of chest XR and chest CT findings was based on parameters including both emergency diagnoses, which are pleural effusion, pulmonary edema, pneumonic consolidation, ground-glass appearance, pneumothorax, atelectasis, hilar congestion, increased cardiothoracic ratio, mediastinal widening, and nonemergency diagnoses, which are parenchymal mass, pleural thickening, multiple nodules, parenchymal cavity, emphysema, bronchiectasis, sequela fibrosis, and vascular congestion. However, pulmonary emboli, pericardial effusion, acute aortic syndromes, abscess, and empyema were not included among the parameters of comparative analysis, given that they could only be detected via chest CT.[7]

Statistical analysis

Statistical analysis was made using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY). The Pearson Chi-square (χ^2) test with exact and Monte Carlo simulation methods and Benjamini–Hochberg corrected *P*-values were used for comparison of the categorical data. The Mann–Whitney U-test (Monte Carlo) and Kruskal–Wallis (Monte Carlo) test with *post hoc* Dunn's test were used to analyze parametric variables. The consistency between the two imaging methods was analyzed using the kappa statistics with the identification of inter-method agreement based on Cohen's kappa coefficient (κ) values that vary from 0 to 1 (0 = agreement equivalent to chance, 0.1–0.20 = slight agreement, 0.21–0.40 = fair agreement, 0.41–0.60 = moderate agreement, 0.61–0.80 = substantial agreement, 0.81–0.99 = near perfect agreement, and 1 = perfect agreement). Data were expressed as mean (standard deviation; SD), minimum–maximum, and percent (%), where appropriate, with $P < 0.05$ considered statistically significant.

Results

During the study period from January 2017 to December 2017, of the 876 patients initially enrolled, 315 patients were excluded as a result of inappropriate imaging techniques (n = 28) and where an interval of more than 6 hours occurred between chest XR and chest CT (n = 287); the data of the remaining 561 patients were subjected to analysis [Figure 1].

Patient demographics and imaging findings

The mean (SD) age was 64.1 (SD 18.4, range 19–95) years (44.9% in 61–80 years) with males comprising 59.0% of the study population. The majority of chest XR views were PA (88.4%), and 64.5% and 19.1% were of moderate- and high-quality chest XR [Table 1].

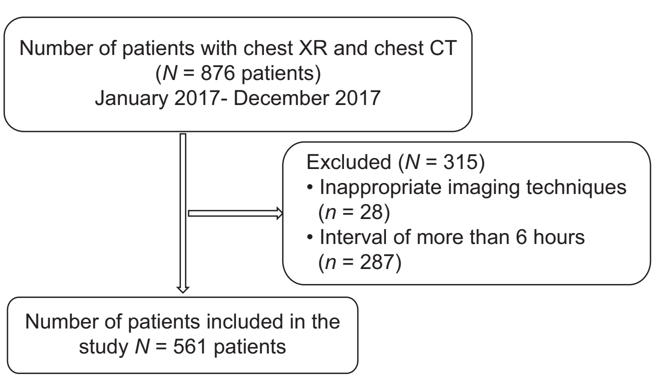

Figure 1: Study flow diagram

The three most common findings in chest XR were vascular congestion, ground-glass appearance, and atelectasis, as noted in 391 (69.7%), 386 (68.8%), and 338 (60.2%) patients, respectively. In chest CT, mediastinal widening, atelectasis, and sequela fibrosis were the three most common findings, being noted in 290 (51.7%), 256 (45.6%), and 246 (43.9%) patients, respectively [Table 1].

Chest XR and chest CT revealed normal findings in 213 (27.5%) and 140 (15.9%) patients, respectively. Pneumonia was the most commonly identified diagnosis by both methods (34.7% and 27.6%, respectively), followed by parenchymal mass (13.4%) and chronic heart failure (10.8%) in chest XR [Table 1].

Diagnostic performance of chest XR in detecting chest CT findings and kappa consistency between two imaging methods

When chest XR and chest CT findings were evaluated in terms of diagnostic performance of chest XR in detecting chest CT findings, the sensitivity of chest XR was 76.35% (95% CI: 68.68 to 82.94), 74.18% (95% CI: 68.21 to 79.55), 73.33% (95% CI: 54.11 to 87.72), and 72.27% (95% CI: 66.35 to 77.66) for detecting pleural effusion, pneumonic consolidation, pulmonary edema, and atelectasis, respectively, specificity for pneumothorax (100.0%, 95% CI: 99.33 to 100), bronchiectasis (95.83%, 95% CI: 93.70 to 97.40), and multiple nodules (93.31%, 95% CI: 90.73 to 95.35). Other statistical data on chest radiography are shown in Table 2.

The consistency between the two methods was evident only for six parameters, including a moderate agreement in detecting pleural effusion (consistency rate: 82.5%, $\kappa = 0.576$, 95% CI: 0.502 to 0.650, $P < 0.001$), pneumothorax (consistency rate: 98.9%, $\kappa = 0.567$, 95% CI: 0.257 to 0.877, $P < 0.001$), increased cardiothoracic ratio (consistency rate: 72.5%, $\kappa = 0.472$, 95% CI: 0.407 to 0.537, $P < 0.001$), and pneumonic consolidation (consistency rate: 73.4%, $\kappa = 0.465$, 95% CI: 0.392 to 0.538, $P < 0.001$), and other parameters are shown in Table 3.

Consistency rate and presence of diagnostic consistency between the two imaging methods according to patient demographics and type and quality of chest XR

No significant gender influence was noted in the consistency rate for the findings or in the percentage

Table 1: Patient demographics and imaging findings

		Mean, median, *n*, %
Age (year)	Mean (SD)	64.1 (18.4)
	Median (min–max)	68.0 (19-95)
Age category (%)	≤30 year	40 (7.1)
	31–40 year	35 (6.2)
	41–60 year	115 (20.5)
	61–80 year	252 (44.9)
	>80 year	119 (21.2)
Gender (*n*(%))	Female	230 (41.0)
	Male	331 (59.0)
Type of chest XR (*n*(%))	Anteroposterior view	65 (11.6)
	Posteroanterior view	496 (88.4)
Chest XR quality (*n*(%))	Poor	92 (16.4)
	Moderate	362 (64.5)
	High	107 (19.1)
Findings (*n*(%))	**Chest XR**	**Chest CT**
Pleural effusion	176 (31.4)	148 (26.4)
Pleural thickening	292 (52.0)	107 (19.1)
Pulmonary edema	83 (14.8)	30 (5.3)
Pneumonic consolidation	267 (47.6)	244 (43.5)
Ground-glass appearance	386 (68.8)	172 (30.7)
Parenchymal mass	95 (16.9)	26 (4.6)
Parenchymal cavity	13 (2.3)	67 (11.9)
Pneumothorax	4 (0.7)	10 (1.8)
Mediastinal widening	126 (22.5)	290 (51.7)
Multiple nodules	49 (8.7)	68 (12.1)
Solitary nodule	22 (3.9)	66 (11.8)
Atelectasis	338 (60.2)	256 (45.6)
Bronchiectasis	44 (7.8)	57 (10.2)
Emphysema	319 (56.9)	195 (34.8)
Sequela fibrosis	230 (41.0)	246 (43.9)
Hilar congestion	217 (38.7)	65 (11.6)
Increased cardiothoracic ratio	313 (55.8)	183 (32.6)
Vascular congestion	391 (69.7)	105 (18.7)
Normal findings	213 (27.5)	140 (16.0)
Diagnoses (*n*(%))	**Chest XR**	**Chest CT**
Pneumonia	269 (34.7)	242 (27.6)
Parenchymal mass	104 (13.4)	47 (5.4)
Chronic heart failure	84 (10.8)	80 (9.1)
Chronic obstructive pulmonary disease	61 (7.9)	104 (11.9)
Tuberculosis	18 (2.3)	10 (1.1)
Interstitial lung disease	12 (1.5)	15 (1.7)
Pulmonary hypertension	3 (0.4)	70 (8.0)
Massive pulmonary effusion	1 (0.1)	
Pulmonary emboli	-	9 (1.0)
Aneurysm	-	5 (0.6)
Acute aortic syndrome	-	1 (0.1)
Other	-	44 (5.0)

of patients with diagnostic consistency for the two imaging methods. The consistency rate for findings with two imaging methods was significant in patients aged <40 years (95.5% in ≤30 years and 90.9% in 31–40 years), as compared to older patients (81.8%, 68.2%, and 72.7% in 41–60 years, 61–80 years, and >80 years, respectively; $P < 0.001$ for each). The consistency rate for findings was also higher in patients aged 41–60 years as compared to those aged 61–80 and >80 years ($P < 0.001$ for each) [Table 4].

Table 2: Diagnostic performance of chest XR in detecting chest CT findings

	Sensitivity (95% CI)	Specificity (95% CI)	+LR (95% CI)	-LR (95% CI)	+PV (95% CI)	-PV (95% CI)
Pleural effusion	76.35 (68.68 to 82.94)	84.75 (80.91 to 88.07)	5.01 (3.92 to 6.39)	0.28 (0.21 to 0.37)	64.20 (58.42 to 69.61)	90.91 (88.19 to 93.05)
Pleural thickening	70.09 (60.48 to 78.56)	52.20 (47.50 to 56.88)	1.47 (1.25 to 1.72)	0.57 (0.42 to 0.78)	25.68 (22.81 to 28.79)	88.10 (84.54 to 90.93)
Pulmonary edema	73.33 (54.11 to 87.72)	88.51 (85.49 to 91.10)	6.38 (4.64 to 8.79)	0.30 (0.17 to 0.55)	26.51 (20.76 to 33.18)	98.33 (97.01 to 99.07)
Pneumonic consolidation	74.18 (68.21 to 79.55)	72.87 (67.62 to 77.69)	2.73 (2.25 to 3.32)	0.35 (0.28 to 0.44)	67.79 (63.39 to 71.89)	78.57 (74.58 to 82.09)
Ground-glass appearance	84.88 (78.64 to 89.88)	38.30 (33.45 to 43.34)	1.38 (1.24 to 1.52)	0.39 (0.27 to 0.57)	37.82 (35.49 to 40.22)	85.14 (79.74 to 89.30)
Parenchymal mass	46.15 (26.59 to 66.63)	84.49 (81.14 to 87.45)	2.97 (1.88 to 4.71)	0.64 (0.45 to 0.91)	12.63 (8.36 to 18.63)	97 (95.76 to 97.88)
Parenchymal cavity	13.43 (6.33 to 23.97)	99.19 (97.94 to 99.78)	16.59 (5.25 to 52.38)	0.87 (0.79 to 0.96)	69.23 (41.61 to 87.66)	89.42 (88.49 to 90.28)
Pneumothorax	40 (12.16 to 73.76)	100 (99.33 to 100)	NA	0.60 (0.36 to 1)	100%	98.92 (98.23 to 99.35)
Mediastinal widening	25.52 (20.60 to 30.94)	80.81 (75.61 to 85.32)	1.33 (0.97 to 1.82)	0.92 (0.84 to 1.01)	58.73 (50.98 to 66.07)	50.34 (48.12 to 52.57)
Multiple nodules	23.53 (14.09 to 35.38)	93.31 (90.73 to 95.35)	3.52 (2.05 to 6.04)	0.82 (0.72 to 0.94)	32.65 (22.02 to 45.43)	89.84 (88.55 to 91)
Solitary nodule	10.61 (4.37 to 20.64)	96.97 (95.05 to 98.29)	3.50 (1.48 to 8.27)	0.92 (0.85 to 1)	31.82 (16.50 to 52.43)	89.05 (88.20 to 89.85)
Atelectasis	72.27 (66.35 to 77.66)	49.84 (44.09 to 55.59)	1.44 (1.26 to 1.65)	0.56 (0.44 to 0.70)	54.73 (51.37 to 58.06)	68.16 (63.03 to 72.88)
Bronchiectasis	40.35 (27.56 to 54.18)	95.83 (93.70 to 97.40)	9.68 (5.73 to 16.36)	0.62 (0.50 to 0.77)	52.27 (39.33 to 64.92)	93.42 (91.98 to 94.62)
Emphysema	68.21 (61.17 to 74.67)	49.18 (43.95 to 54.43)	1.34 (1.17 to 1.54)	0.65 (0.51 to 0.81)	41.69 (38.36 to 45.11)	74.38 (69.75 to 78.52)
Sequela fibrosis	55.28 (48.84 to 61.60)	70.16 (64.77 to 75.16)	1.85 (1.51 to 2.27)	0.64 (0.55 to 0.75)	59.13 (54.14 to 63.94)	66.77 (63.21 to 70.14)
Hilar congestion	55.38 (42.53 to 67.73)	63.51 (59.10 to 67.75)	1.52 (1.19 to 1.94)	0.70 (0.53 to 0.93)	16.59 (13.45 to 20.30)	91.57 (89.15 to 93.49)
Increased cardiothoracic ratio	93.44 (88.83 to 96.57)	62.43 (57.34 to 67.33)	2.49 (2.17 to 2.85)	0.11 (0.06 to 0.18)	54.63 (51.26 to 57.97)	95.16 (91.88 to 97.16)
Vascular congestion	95.24 (89.24 to 98.44)	36.18 (31.77 to 40.78)	1.49 (1.38 to 1.62)	0.13 (0.06 to 0.31)	25.58 (24.06 to 27.15)	97.06 (93.29 to 98.74)

NA: not available

The two methods revealed consistent diagnoses in a significantly higher percentage of patients aged ≤30 years (92.5%, $P < 0.001$ for each) as compared to patients aged 41–60 years (70.4%), 61–80 years (51.2%), and >80 years (49.6%). No significant difference was noted in the prevalence of consistent diagnoses between ≤30 year and 31- to 40-year age groups (92.5% vs. 80.0%, respectively), whereas consistent diagnoses were also higher in patients aged 41–60 years as compared to those aged 61–80 years and >80 years ($P < 0.001$ for each).

The consistency rate for findings (72.7% vs. 68.2%, $P = 0.005$) and the percentage of patients with consistent diagnoses (61.1% vs. 47.7%, $P = 0.044$) were significantly higher for PA than for AP chest XR views [Table 4].

The consistency rate for findings was significantly higher for high- and moderate-quality chest XR views than for poor-quality views (72.7% and 77.3% vs. 70.5%, $P = 0.001$), while the percentage of patients with consistent diagnoses was also significantly higher for moderate vs. poor-quality chest XR views (62.4% vs. 46.7%, $P = 0.022$) [Table 4].

Discussion

Our findings in a retrospective cohort of patients with nontraumatic respiratory emergencies revealed consistency with fair-to-moderate agreement between chest XR and chest CT methods in the identification of pleural effusion, pneumothorax, increased cardiothoracic ratio, pneumonic consolidation, pulmonary edema, sequela fibrosis, and atelectasis.

Table 3: Kappa consistency between two imaging methods

Chest XR	Consistency		κ (95% CI)	*P*
	Absent	Present		
Pleural effusion	98 (17.5)	463 (82.5)	0.576 (0.502 to 0.650)	<0.001
Pleural thickening	249 (44.4)	312 (55.6)	0.134 (0.071 to 0.197)	<0.001
Pulmonary edema	69 (12.3)	492 (87.7)	0.337 (0.223 to 0.451)	<0.001
Pneumonic consolidation	149 (26.6)	412 (73.4)	0.465 (0.392 to 0.538)	<0.001
Ground-glass appearance	266 (47.4)	295 (52.6)	0.172 (0.115 to 0.229)	<0.001
Parenchymal mass	97 (17.3)	464 (82.7)	0.135 (0.043 to 0.227)	<0.001
Parenchymal cavity	62 (11.1)	499 (88.9)	0.194 (0.078 to 0.310)	<0.001
Pneumothorax	6 (1.1)	555 (98.9)	0.567 (0.257 to 0.877)	<0.001
Mediastinal widening	268 (47.8)	293 (52.2)	0.062 (-0.005 to 0.129)	0.086
Multiple nodules	85 (15.2)	476 (84.8)	0.191 (0.077 to 0.305)	<0.001
Solitary nodule	74 (13.2)	487 (86.8)	0.107 (0.003 to 0.211)	0.01
Atelectasis	224 (39.9)	337 (60.1)	0.215 (0.139 to 0.291)	<0.001
Bronchiectasis	55 (9.8)	506 (90.2)	0.403 (0.276 to 0.530)	<0.001
Emphysema	248 (44.2)	313 (55.8)	0.151 (0.078 to 0.224)	<0.001
Sequela fibrosis	204 (36.4)	357 (63.6)	0.256 (0.176 to 0.336)	<0.001
Hilar congestion	210 (37.4)	351 (62.6)	0.094 (0.027 to 0.161)	0.004
Increased cardiothoracic ratio	154 (27.5)	407 (72.5)	0.472 (0.407 to 0.537)	<0.001
Vascular congestion	296 (52.8)	265 (47.2)	0.153 (0.114 to 0.192)	<0.001

Kappa test (Monte Carlo); κ : Cohen's kappa coefficient; CI: confidence interval; NA: not available

Table 4: Consistency rate and presence of diagnostic consistency with two imaging methods according to patient demographics and type and quality of chest XR

Variables	Consistency rate (%) for findings (median (min/max))	Diagnosis (*n* (%))	
		Not consistent	Consistent
Gender			
Female	72.7 (45.5/100)	94 (40.9)	136 (59.1)
Male	72.7 (40.9/100)	133 (40.2)	198 (59.8)
P	0.526[1]	0.930[2a]	
Age			
≤30	95.5 (63.6/100.0)	3 (7.5)	37 (92.5)
31–40	90.9 (68.2/100.0)	7 (20.0)	28 (80.0)
41–60	81.8 (40.9/100.0)[*,q]	34 (29.6)	81 (70.4)[*]
61–80	68.2 (45.5/95.5)[*,q,w]	123 (48.8)	129 (51.2)[*,q,w]
>80	72.7 (45.5/90.9)[*,q, w]	60 (50.4)	59 (49.6)[*,q,w]
P	<0.0013	<0.001[2b]	
Type of chest XR			
Anteroposterior view	68.2 (45.5/90.9)	34 (52.3)	31 (47.7)
Posteroanterior view	72.7 (40.9/100)	193 (38.9)	303 (61.1)
P	0.005[1]	0.044[2a]	
Chest XR quality			
Poor	70.5 (45.5/100)	49 (53.3)	43 (46.7)
Moderate	72.7 (45.5/100)[t]	136 (37.6)	226 (62.4)[t]
High	77.3 (40.9/100)[t]	42 (39.3)	65 (60.7)
P	0.001[2]	0.022[2b]	

min: minimum; max: maximum. [1]Mann–Whitney *U*-test (Monte Carlo), [2]Pearson's Chi-square test ([a]exact, [b]Monte Carlo), [3]Kruskal–Wallis test (Monte Carlo), post hoc test : Dunn's test. *$P<0.001$, compared with ≤30 years of age; [q]$P<0.001$, compared with 31–40 years of age; [w]$P<0.001$, compared to 41–60 years of age, [t]$P=0.001$ compared with poor quality

The rate of consistency between chest XR findings and CT findings decreases inversely with increasing age. For example, while the consistency rate is 95.5% and 90.9% for those below 30 and 31–40 years old, respectively, it decreases in groups over 40 years old. We attribute this high consistency rate to the absence of chronic pulmonary pathologies, especially in the patient population below 40 years of age. When the two groups were compared separately with the groups over 40 years old, it was seen that there was a statistically significant difference.

AP chest XR view was mostly applied to patients in the supine position. These patients generally had advanced age, comorbid diseases, and chronic sequelae changes. However, we think that the PA chest XR view consists of relatively younger patients with fewer comorbid diseases. In addition, as the quality of the chest XR increases, the consistency rate of lung findings increases proportionally.

Pleural fluid in the chest XR taken in PA view causes the costophrenic angle to blunt and the diaphragm to flatten. These signs are only noticeable in chest XR if there is about 200 ml or even more (sometimes up to 500 ml) of fluid present in the lungs.[13] This amount is further increased in the supine position to detect it on chest XR. In our retrospective analysis, we found that the consistency rate of chest XR with CT in detecting pleural effusion was 82.5% [Table 3]. However, in a past study in patients with nontraumatic respiratory emergencies, the authors reported that the sensitivity of chest XR in detecting pleural effusion appears to be lower than in our study.[7] While only 11.6% of our patients had anterior–posterior view, this rate was 44% in their study, which explains the difference. Pleural effusion is considered an important finding in relation to its indication of the need for further diagnostic testing for pneumonia and its contribution to a diagnosis of cardiac failure.[7,14]

In our study, we found that both the sensitivity and the selectivity of chest XR for pneumonic consolidation were low [Table 2]. This result was consistent with the results of similar studies in the literature.[7,15] In particular, patients in the advanced age group can have many comorbid diseases. Therefore, it may be difficult to obtain a chest XR in PA view in this patient group. Therefore, chest XRs are taken in the patients in the supine or sitting position. In a meta-analysis including five studies to compare lung ultrasonography and chest XR for the diagnosis of community-acquired pneumonia in adult patients, they found the sensitivity of chest XR to be 0.77 and the specificity to be 0.91.[16] Carraro *et al.*[15] reported a sensitivity of 77% and a specificity of 74% with less than 50% PPV and NPV for the diagnosis of pneumonia. İn a prospective study, of the hospitalized bedridden patients with a moderate to high probability of clinical pneumonia, 58 patients were evaluated for 5 months. The sensitivity of chest radiography in the diagnosis of pneumonia was 65%, the specificity was 93%, and the positive and negative predictive values were 83% and 65%, respectively.[17]

The basal regions of the lung are the most difficult to interpret due to atelectasis and pleural effusion. A study examined the accuracy of supine chest XR, specifically in the basal lung zones, which are most frequently affected by pneumonia. They found that the most common findings in false-positive cases were combined pleural effusions and lower lobe atelectasis.[18] However, guidelines still recommend chest XR for patients with suspected community-acquired pneumonia.[14]

One of the life-threatening pathologies is pneumothorax. We had only 10 patients with signs of pneumothorax on chest CT. In our retrospective analysis, we found that the sensitivity of pneumothorax was low, but its specificity was 100%. This statistic was compatible with the literature.[19] AP chest XR of the patient in the supine position has significant limitations. The limitation is due to the air in the pleural space diffusing toward the anterior wall of the thorax. In a meta-analysis with 13 articles meeting the criteria, pleural ultrasonography was compared with chest XR for the diagnosis of pneumothorax. The results of the meta-analysis in terms of diagnosis accuracy of pneumothorax on chest XR were correlated with the results of our study. Its sensitivity was 39.8% (95% CI, 29.4 to 50.3) and specificity was 99.3% (95% CI, 98.4 to 100), respectively.[20]

In the diagnosis of alveolar–interstitial pulmonary edema, the accuracy of chest XR was shown to be only 72% compared with chest CT in a case–control study.[21] There is usually a difference in 12 hours between the clinical and physiological manifestations of congestive heart failure and the appearance of radiographic findings.[22] Because of this limitation, we limited the time between chest radiography and chest CT to 6 hours in our study. Although the sensitivity and specificity of XR were low in the diagnosis of pulmonary edema, these results were consistent with the literature.[7,21] Given that the radiologists were not aware of the clinical status of the patients, the high false positivity rate in our cohort may be linked to the high likelihood of chest XR findings related to bilateral lower lobe pneumonia and sequelae due to chronic disease being misdiagnosed as pulmonary edema, where radiography findings are not interpreted within the context of patient history and physical examination findings.

Moreover, emergency doctors and nurses have a limited understanding of the dangers and dosages associated with radiation exposure in the emergency department (ED).[23] Considering the increasing use of CT in our country, the use of XR should be kept in mind as the first choice, especially in patients under the age of 40 who apply to the emergency department.

Limitations

Certain limitations to this study should be considered. Firstly, due to the retrospective, single-center design of the present study, it is not possible to establish the temporal relationship between cause and effect and to generalize our findings to the overall patient population. Second, the rarity of certain imaging findings in our cohort limited their inclusion in the statistical analysis. Third, the considerable difference between rates of AP and PA techniques and the poor to moderate quality of a large number of chest XR images is another limitation of the current study.

Conclusions

The consistency between the two methods was more likely in patients aged <40 years, with PA and moderate- to high-quality chest XR views, as compared to older patients and AP and poor-quality views, respectively. Given the association of poor-quality chest XR images and advanced patient age with a lower likelihood of concordance with chest CT results, our findings emphasize the diagnostic value of chest CT in older emergency patients admitted with nontraumatic respiratory pathologies. Therefore, we suggest that the upright position of PA chest XR view method with appropriate imaging quality may be the first choice, especially in patients under the age of 40 years who are admitted to the emergency department with respiratory symptoms.

Ethical approval

The study was approved by the ethical review board. The name and date of approval granted by the ethical board are included in the manuscript.

The study was approved by the Ethics Committee of the Health Science University, Izmir Bozyaka Training and Research Hospital. Decision number: 2, date: November 21, 2018.

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Conflicts of interest

There are no conflicts of interest.

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