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ลักษณะของภาพรังสีทรวงอกในผู้ป่วยติดเชื้อโคโรนาไวรัส 2019

Chest Radiographic Findings in COVID-19 patients

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บทคัดย่อ

ภูมิหลัง : โรคติดเชื้อโคโรนาไวรัส 2019 กำลังระบาดอยู่ทั่วโลก ภาพรังสีทรวงอกสามารถใช้ประเมินความรุนแรงของปอดอักเสบจากการติดเชื้อโคโรนาไวรัส 2019 วัตถุประสงค์ : เพื่อศึกษาความสัมพันธ์ของภาพรังสีทรวงอกและอาการแสดงของผู้ป่วยติดเชื้อโคโรนาไวรัส 2019 ศึกษาระยะเวลาและลักษณะการเปลี่ยนแปลงของภาพรังสีทรวงอกนับจากวันที่เริ่มมีอาการแสดง วิธีการ : เป็นการศึกษาแบบย้อนหลังในผู้ป่วยติดเชื้อโคโรนาไวรัส 2019 ได้รับการรักษาที่สถาบันบำราศนราดูรระหว่างวันที่ 1 มกราคม ถึง 1 เมษายน พ.ศ. 2563 แบ่งผู้ป่วยออกเป็น 4 กลุ่ม ได้แก่ ไม่มีอาการ อาการเล็กน้อย อาการปานกลาง และอาการรุนแรง ผู้ป่วยทั้งหมด 158 ราย ได้ศึกษาภาพรังสีทรวงอกเริ่มต้น และผู้ป่วย 135 ราย มีการติดตามภาพรังสีทรวงอก ผล : ผู้ป่วยติดเชื้อโคโรนาไวรัส 2019 ทั้งหมด 158 ราย เป็นผู้ชายร้อยละ 63.3 มีอายุเฉลี่ย 41.8 ปี ภาพรังสีทรวงอกเริ่มต้นมีความผิดปกติร้อยละ 44.3 จากผู้ป่วย 88 ราย ที่มีภาพรังสีทรวงอกเริ่มต้นปกติ พบว่าร้อยละ 17 ภาพรังสีทรวงอกมีความผิดปกติในเวลาต่อมา ภาพรังสีทรวงอกเริ่มต้นพบความผิดปกติของเนื้อปอดชนิด ground glass opacity ร้อยละ 90 ภาพรังสีทรวงอกช่วงที่มีความผิดปกติมากที่สุดพบความผิดปกติของเนื้อปอดชนิด ground glass opacity ร้อยละ 73.8 ความผิดปกติของภาพรังสีทรวงอกส่วนใหญ่พบได้หลายตำแหน่ง พบที่ปอดสองข้าง พบบริเวณตรงกลางร่วมกับบริเวณรอบนอกของปอด และพบบริเวณส่วนล่างของปอด ภาพรังสีทรวงอกเริ่มต้นพบน้ำในช่องเยื่อหุ้มปอดร้อยละ 1.4 ภาพรังสีทรวงอกช่วงที่มีความผิดปกติมากที่สุดพบน้ำในช่องเยื่อหุ้มปอดร้อยละ 10 น้ำในช่องเยื่อหุ้มปอดพบในเฉพาะกลุ่มผู้ป่วยอาการรุนแรง ระยะเวลาเฉลี่ยจากอาการแสดงเริ่มต้นจนถึงช่วงที่ภาพรังสีทรวงอกมีความผิดปกติมากที่สุดคือ 10.9±4.5 วัน สรุป : ผู้ป่วยที่มีอาการปานกลางและอาการรุนแรงอาจมีภาพรังสีทรวงอกเริ่มต้นปกติ ภาพรังสีทรวงอกของผู้ป่วยติดเชื้อโคโรนาไวรัส 2019 ส่วนใหญ่พบความผิดปกติของเนื้อปอดชนิด ground glass opacity พบได้หลายตำแหน่ง พบที่ปอดสองข้าง พบบริเวณตรงกลางร่วมกับบริเวณรอบนอกของปอด และพบบริเวณส่วนล่างของปอด ระยะเวลาเฉลี่ยจากอาการแสดงเริ่มต้นจนถึงช่วงที่ภาพรังสีทรวงอกมีความผิดปกติมากที่สุดคือ 11 วัน

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Abstract

Background: Coronavirus disease 2019 (COVID-19) is an ongoing global pandemic disease. The chest radiograph (CXR) has been used to evaluate severity of COVID-19 pneumonia. Objective: This study aimed to describe the correlation between CXR findings and clinical symptoms in COVID-19 and the time course of lung changes on the CXR relative to the initial symptoms. Methods: This retrospective study evaluated COVID-19 patients treated at the Bamrasnaradura Infectious Disease Institute during January 1 -April 1, 2020. Patients were divided into 4 groups, namely, asymptomatic, mild disease, moderate disease and severe disease. 158 patients included in the study had initial CXR for review. Of which, 135 patients had follow-up CXR available for review. Results: During the study period, there were 158 COVID-19 patients. 63.3% were males. The average age of patients was 41.8 years. Of 158 patients, 44.3% had abnormal initial CXR. Among 88 patients who had normal initial CXR, 17.0% subsequently showed abnormality on the follow-up CXR. The most common parenchymal opacity was ground glass opacity at 90% of the initial CXR and 73.8% of the peak stage CXR. Lesions were more likely to be multifocal and bilateral involvement, both central and peripheral distribution, and lower zone predominant. Pleural effusion was seen in 1.4% of the initial CXR and 10% of the peak stage CXR. Pleural effusion was only found in severe disease group. The mean duration from initial symptoms to the peak stage CXR was 10.9 ± 4.5 days. Conclusion: Patients in moderate and severe disease groups might have normal initial CXR. The most common CXR findings of COVID-19 pneumonia were ground glass opacity, multifocal and bilateral lungs involvement, both central and peripheral distribution and lower lung zone predominant. The duration from initial symptoms to the peak stage CXR was around 11 days.

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คำสำคัญ	**Keywords**
โคโรนาไวรัส 2019, ซาร์ส-โควี-2, ภาพรังสีทรวงอก	*COVID-19, SARS-CoV-2, chest radiograph*

Introduction

In December 2019, an outbreak of a novel coronavirus infection occurred in Wuhan city, Hubei province of China[1]. The novel coronavirus was named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which causes coronavirus disease 2019 (COVID-19)[2]. With the rapid spreading of COVID-19 across the world, COVID-19 was declared a pandemic by the World Health Organization (WHO) on March 11, 2020[3]. The diagnosis of COVID-19 uses positive test for SARS-CoV-2 on real-time reverse transcription polymerase chain reaction (RT-PCR). The most common symptoms of COVID-19 are fever and cough[4]. Most cases experience mild to moderate symptoms[5]. However, approximately 15% of COVID-19 cases suffer severe illness, and about 5% of them have critical disease[5]. Pneumonia appears to be the most frequent serious manifestation of COVID-19. Therefore, imaging plays an important role in the diagnosis and evaluation of disease severity.

In Thailand, the chest radiograph (CXR) is the first diagnostic modality used to evaluate severity of COVID-19 pneumonia. This is because the CXR can be performed in lesser time and its cost is less expensive than the chest computed tomography (CT). The current literature showed the chest CT had a higher sensitivity in diagnosis of COVID-19 pneumonia and may be useful for screening of highly suspected cases[6-9]. The chest CT findings of COVID-19 pneumonia, however, are not specific and overlap with other viral pneumonia and other diseases[10-11]. The objectives of this study were to describe the correlation between CXR findings and clinical symptoms in COVID-19 and the time course of lung changes on the CXR relative to the initial symptoms.

Materials and methods

Study population

This study was approved by the institutional review board. Patient informed consents were not required for this retrospective analysis. From January 1, 2020 to April 1, 2020 at the Bamrasnaradura Infectious Disease Institute, a total of 158 patients over 18 years of age were confirmed to have diagnosis of COVID-19 by having positive test for real-time reverse transcription polymerase chain reaction (RT-PCR) for SARS-CoV-2. Medical charts were reviewed to obtain the information about demographics, comorbidities, initial symptoms and serial results of real-time RT-PCR. 158 patients had initial CXR and 135 patients had follow-up CXRs performed. Patients were divided into 4 groups, namely, asymptomatic; mild disease (symptomatic patients without clinical signs of pneumonia); moderate disease (patients having clinical signs of pneumonia, but no signs of severe pneumonia with oxygen saturation (SpO_2)> 90% on room air); and severe disease (patients having clinical signs of severe pneumonia with SpO_2 < 90% on room air or acute respiratory distress syndrome (ARDS)).

Image acquisition and chest radiograph review

Portable CXRs were acquired in posteroanterior (PA) projection or anteroposterior (AP) projection. Three radiologists independently reviewed all images on a picture archiving and communication system (PACS) workstation. In case of disagreement, we used at least two-third consensus.

Each CXR was first characterized as either normal or abnormal based on lung parenchymal opacity (e.g. ground glass opacity (GGO), consolidation, reticular opacity, reticulonodular opacity), pleural effusion, mediastinal lymph node. GGO was defined as an area of increased hazy lung opacity, within which margins of pulmonary vessels may be indistinct[12]. Consolidation was defined as a homogeneous increased lung opacity that obscures the margins of vessels and airway walls[12]. Reticular opacity was defined as linear opacities resembling a net[12]. Reticulonodular opacity was defined as a combined reticular and nodular pattern[12]. The distribution was characterized as central (4 cm from the hilum) or peripheral and as unifocal, multifocal or diffuse. A unifocal distribution was defined as a single focus of abnormality. A multifocal distribution was described as having more than one focus. A diffuse distribution was defined as a bilateral abnormality involving equivalent volume of both lungs. Laterality was classified as unilateral or bilateral. In addition, the lungs were divided into upper, middle, and lower zones. This was done in the frontal view with each lung divided into 3 portions from the apex to the hemidiaphragm.

Chest radiograph severity score

All CXRs were assessed for the disease extents and severity by using CXR severity score[13]. Each lung zone was assigned a score ranging from 0-4 depending on the extent of abnormal lung parenchymal opacity (0=no involvement; 1=<25%; 2 =25-50%; 3=51-75%; and 4=>75% involvement). The total CXR severity score was the sum of all six zones per CXR and ranged from 0 (no involvement) to 24 (maximum involvement). Examples are given in Figure 1.

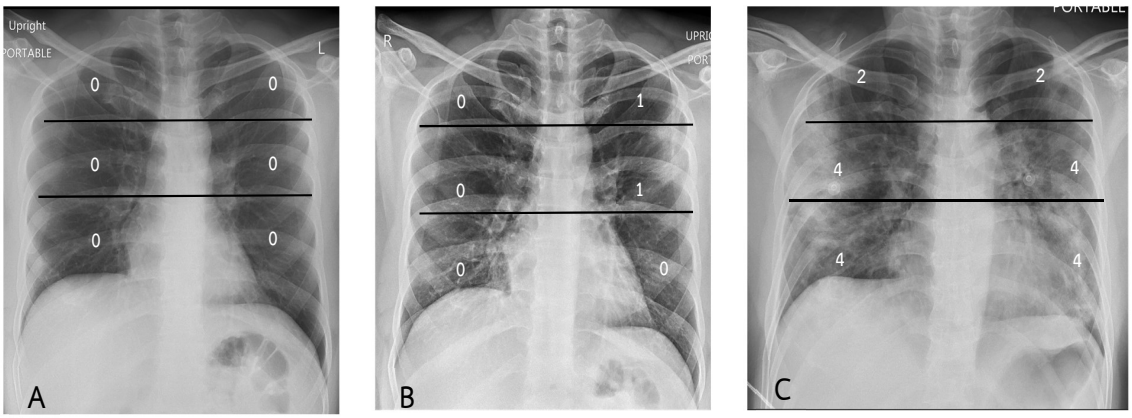

Figure 1: : Frontal CXR of a 42-year-old male with COVID-19 pneumonia, CXR severity score were shown in all six lung zones. (A) Day 4 from initial symptoms: no parenchymal opacity, CXR severity score = 0. (B) Day 8 from initial symptoms: GGO at peripheral area of left upper and middle lung zones, CXR severity score = 2. (C) Day 18 from initial symptoms: mixed GGO and consolidation of both lungs, CXR severity score = 20.

Statistical analyses

Descriptive and inferential statistics were performed. Descriptive statistics were reported as frequency, percentage or mean and standard deviation. The t-test and the chi-square test were used to compare between groups.

Results

Clinical characteristics

The clinical characteristics of 158 COVID-19 patients were summarized in Table 1. There were 100 males (63.3%) and 58 females (36.7%) with a mean age of 41.8 years (range 20-79 years). All patients were divided into 4 groups: 5.7% were in asymptomatic group, 46.8% were in mild disease group, 34.2% were in moderate disease group, and 13.3% were in severe disease group.

Chest radiograph findings

Among the 158 patients, 44.3% had abnormal initial CXR. Of 54 patients in moderate disease group, 81.5% had abnormal initial CXR. Of 21 patients in severe disease group, 85.7% had abnormal initial CXR (Table 1).

Of 70 patients who had abnormal initial CXR, the most common parenchymal opacity was GGO (90%) (Figure 2A). Lesions were more likely to be multifocal (62.9%), have bilateral involvement (61.4%), have both central and peripheral distribution (48.6%), and be lower zone predominant (81.4%) (Table 2). One patient in severe disease group, who

had pulmonary tuberculosis, had initial CXR showing diffuse reticulonodular opacity in both lungs and mediastinal lymph node at left hilar region. Pleural effusion was seen in a patient (1.4%) who was in severe disease group.

Of 88 patients who had normal initial CXR, 17% subsequently showed abnormality on the follow-up CXR. The mean duration from initial symptoms to CXR abnormality was 6.6 days (SD±2.4; range 2-12 days).

Of 158 patients, 135 (85.4%) had the follow-up CXR. Of which, 59.3% had abnormality on the follow-up CXR. Of 80 patients who had the abnormal follow-up CXR, the most common parenchymal opacity at peak stage was GGO (73.8%), followed by mixed GGO and consolidation (23.8%) (Figure 2B). The distribution of lesions was multifocal (68.8%), bilateral involvement (83.8%), both central and peripheral distribution (80%), and lower zone predominant (92.5%) (Table 3). Pleural effusion was seen in 8 patients (10%) who were in severe disease group. There were 4 deaths. All of them developed ARDS and their CXR showed pleural effusion (Figure 3).

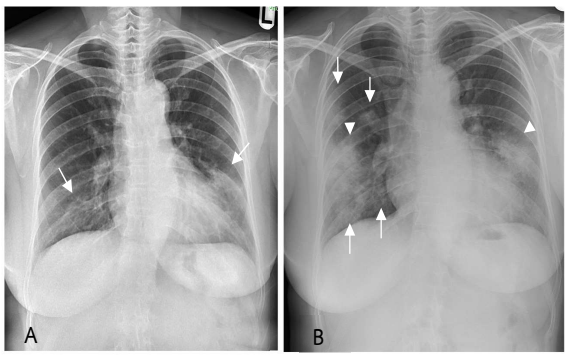

Figure 2: Frontal CXR in a 53-year-old-female with COVID-19 pneumonia. (A) The initial CXR (day 8 from initial symptoms) shows GGO (arrow) at both lower lung zones. (B) The follow-up CXR (day 12 from initial symptoms) shows GGO (arrow) and consolidation (arrowhead) at right lung and consolidation (arrowhead) at left middle and lower lung zones.

Figure 3: Frontal CXR in a 79 year-old male with COVID-19 and ARDS. (A) The initial CXR (day 8 from initial symptoms) shows GGO at right perihilar region and right lower lung zone. (B) The follow-up CXR (day 10 from initial symptoms) shows increased GGO of both lungs and consolidation at both lower lung zones. (C) The follow-up CXR (day 13 from initial symptoms) shows increased GGO and consolidation of both lungs with bilateral pleural effusion.

Chest radiograph severity score

Of 158 patients, the mean score of initial CXR severity score was 2.8 (SD±4.8; range 0-24). The initial CXR severity score was significantly higher in severe disease group (mean 8.3; SD±7.4; range 0-24; p<0.001) (Table 4).

Of 149 patients (all patients except asymptomatic group), the mean duration from initial symptoms to the initial CXR was 4.9 days (SD±3.9; range 1-27). There was no significant difference of the duration from initial symptoms to the time of having initial CXR among 4 groups (p=0.629) (Table 5).

CXR severity score changed over time. Of 80 patients who had abnormality on the follow-up CXR, the mean score of the peak CXR severity score was 13.0 (SD±7.5; range 1-24). The mean score of the peak CXR severity score was significantly higher in severe disease group (mean 20.9; SD±2.6; range 16-24; p<0.001) (Table 6). The mean duration from initial symptoms to the peak stage CXR was 10.9 days (SD±4.5; range 1-25) (Table 6).

Table 1 Characteristic of 158 COVID-19 patients

Characteristic	All (n=158)	Asymptomatic (n=9)	Mild disease (n=74)	Moderate disease (n=54)	Severe disease (n=21)	p-value
Sex						0.056
- Male	100 (63.3)	6 (66.7)	40 (54.1)	36 (66.7)	18 (85.7)	
- Female	58 (36.7)	3 (33.3)	34 (45.9)	18 (33.3)	3 (14.3)	
Age (years)						<0.001
Mean	41.8	37.3	34.2	47.9	54.5	
Range	20-79	23-66	20-62	23-74	31-79	
Symptoms						
- Fever	104 (65.8)	0 (0)	44 (59.5)	41 (75.9)	19 (90.5)	<0.001
- Cough	80 (50.6)	0 (0)	49 (66.2)	12 (22.2)	19 (90.5)	<0.001
- Dyspnea	15 (9.5)	0 (0)	3 (4.1)	6 (11.1)	6 (28.6)	0.006
- Rhinorrhea	40 (25.3)	0 (0)	25 (33.8)	9 (16.7)	6 (28.6)	0.044
- Nasal congestion	11 (6.9)	0 (0)	10 (13.5)	0 (0)	1 (4.8)	0.021
- Sore throat	32 (20.3)	0 (0)	20 (27)	10 (18.5)	2 (9.5)	0.011
- Chest discomfort	11 (6.9)	0 (0)	6 (8.1)	4 (7.4)	1 (4.8)	0.802
- Headache	22 (13.9)	0 (0)	11 (14.9)	10 (18.5)	1 (2.8)	0.2
Abnormal initial CXR	70 (44.3)	1 (11.1)	7 (9.5)	44 (81.5)	18 (85.7)	<0.001
Death	4 (2.5)	0 (0)	0 (0)	0 (0)	4 (19)	0.001

Note-Data are number with percentage in parentheses

Table 2 Radiographic findings of the abnormal initial CXR in 70 COVID-19 patients

Radiographic findings	All (n=70)	Asymptomatic (n=1)	Mild disease (n=7)	Moderate disease (n=44)	Severe disease (n=18)	*p*-value
Parenchymal opacity						<0.001
- GGO	63 (90)	0 (0)	7 (100)	41 (93.2)	15 (83.3)	
- GGO and consolidation	4 (4.3)	0 (0)	0 (0)	2 (4.5)	2 (11.1)	
- GGO and reticular	2 (2.9)	1 (100)	0 (0)	1 (2.3)	0 (0)	
- Reticulonodular	1 (1.4)	0 (0)	0 (0)	0 (0)	1 (5.6)	
Transverse distribution						0.147
- Peripheral	5 (7.1)	0 (0)	1 (14.3)	4 (9.1)	0 (0)	
- Central	31 (44.3)	0 (0)	5 (71.4)	21 (47.7)	5 (27.8)	
- Both peripheral and central	34 (48.6)	1 (100)	1 (14.3)	19 (43.2)	13 (72.2)	
Scattered distribution						0.019
- Unifocal	18 (25.7)	0 (0)	5 (71.4)	9 (20.5)	4 (22.2)	
- Multifocal	44 (62.9)	1 (100)	2 (28.6)	32 (72.7)	9 (50)	
- Diffuse	8 (11.4)	0 (0)	0 (0)	3 (6.8)	5 (27.8)	
Lung region distribution						0.188
- Unilateral	27 (38.6)	1 (100)	5 (71.4)	17 (38.6)	4 (22.2)	
Right lung	21	1	4	12	4	
Left lung	6	0	1	5	0	
- Bilateral	43 (61.4)	0 (0)	2 (28.6)	27 (61.4)	14 (77.8)	
Craniocaudal distribution						
- Upper zone	21 (30)	1 (100)	2 (28.6)	10 (22.7)	8 (44.4)	0.155
- Middle zone	51 (72.9)	1 (100)	4 (57.1)	32 (72.7)	14 (77.8)	0.690
- Lower zone	57 (81.4)	1 (100)	3 (42.9)	36 (81.8)	17 (94.4)	0.028
Pleural effusion	1 (1.4)	0 (0)	0 (0)	0 (0)	1 (5.6)	0.402

Note-Data are number with percentage in parentheses.

Table 3 Radiographic findings of the peak stage chest radiograph in 80 COVID-19 patients

Radiographic findings	All (n=80)	Mild disease (n=7)	Moderate disease (n=52)	Severe disease (n=21)	*p*-value
Parenchymal opacity					<0.001
- GGO	59 (73.8)	7 (100)	48 (92.3)	4 (19)	
- GGO and consolidation	19 (23.8)	0 (0)	3 (5.8)	16 (76.2)	
- GGO and reticular	1 (1.3)	0 (0)	1 (1.9)	0 (0)	
- Reticulonodular	1 (1.3)	0 (0)	0 (0)	1 (4.8)	

Table 3 Radiographic findings of the peak stage chest radiograph in 80 COVID-19 patients

Radiographic findings	All (n=80)	Mild disease (n=7)	Moderate disease (n=52)	Severe disease (n=21)	*p*-value
Transverse distribution					<0.001
- Peripheral	3 (3.8)	1 (14.3)	2 (3.8)	0 (0)	
- Central	13 (16.3)	6 (85.7)	7 (13.5)	0 (0)	
- Both peripheral and central	64 (80)	0 (0)	43 (82.7)	21 (100)	
Scattered distribution					<0.001
- Unifocal	10 (12.5)	6 (85.7)	4 (7.7)	0 (0)	
- Multifocal	55 (68.8)	1 (14.3)	41 (78.8)	13 (61.9)	
- Diffuse	15 (18.8)	0 (0)	7 (13.5)	8 (38.1)	
Lung region distribution					
- Unilateral	13 (16.3)	6 (85.7)	7 (13.5)	0	
Right lung	10	3	7	0	
Left lung	3	3	0	0	
- Bilateral	67 (83.8)	1 (14.3)	45 (86.5)	21 (100)	
Craniocaudal distribution					
- Upper zone	48 (60)	2 (28.6)	25 (48.1)	21 (100)	<0.001
- Middle zone	69 (86.3)	4 (57.1)	44 (84.6)	21 (100)	0.015
- Lower zone	74 (92.5)	3 (42.9)	50 (96.2)	21 (100)	<0.001
Pleural effusion	8 (10)	0 (0)	0 (0)	8 (38.1)	<0.001

Note-Data are number with percentage in parentheses.

Table 4 Initial chest radiograph severity score

Initial chest radiograph severity score	All (n=158)	Asymptomatic (n=9)	Mild disease (n=74)	Moderate disease (n=54)	Severe disease (n=21)	*p*-value
Mean±SD (range)	2.8±4.8 (0-24)	0.7±2.0 (0-6)	0.2±0.6 (0-4)	4.6±4.5 (0-18)	8.3±7.4 (0-24)	<0.001

Table 5 The duration from initial symptoms to the time of having initial chest radiograph

The duration from initial symptoms to the time of having initial chest radiograph (days)	All (n=149)	Mild disease (n=74)	Moderate disease (n=54)	Severe disease (n=21)	*p*-value
Mean±SD (range)	4.9±3.9 (1-27)	5.1±4.4 (1-27)	4.4±3.6 (1-16)	5.0±2.4 (1-10)	0.629

Table 6 Peak chest radiograph severity score and the duration from initial symptoms to the peak stage chest radiograph

Variable	All (n=80)	Mild disease (n=7)	Moderate disease (n=52)	Severe disease (n=21)	*p*-value
Peak chest radiograph severity score, mean±SD (range)	13.0±7.5 (1-24)	2.0±2.2 (1-7)	11.4±6.2 (1-22)	20.9±2.6 (16-24)	<0.001
The duration from initial symptoms to the peak stage chest radiograph (days), mean±SD (range)	10.9±4.5 (1-25)	6.7±2.5 (4-11)	10.8±4.6 (1-25)	12.5±3.9 (5-19)	0.012

Discussion

COVID-19 is an ongoing global pandemic disease. Our study evaluated and analyzed the characteristics and CXRs of 158 COVID-19 patients. Patients were divided into 4 groups: asymptomatic, mild disease, moderate disease, and severe disease group. Most patients were in mild disease group (46.8%). Most patients were males (63.3%) as a large number of patients were from the boxing stadium cluster identified in March 2020 in Thailand. However, there was no significant difference in sex distribution between 4 groups (p=0.056). The mean age of COVID-19 patients was 41.8 years (range 20-79 years). Older adults had significantly increased risk of having severe disease (p<0.001) which is similar to Starke et al. reported an increased age-related risk of COVID-19 disease severity, however, age-related comorbidities were more important than age itself[14]. In term of symptoms, fever was the most common symptom (65.8%), followed by cough (50.6%), which is consistent with the previous studies[6-8, 15].

In our study, 44.3% had abnormal initial CXR. Most patients in moderate and severe disease groups had abnormality on the initial CXR. Of 88 patients who had normal initial CXR, 17% developed abnormalities on follow-up CXRs which are consistent with the previous study[16]. In our study, a small number of patients in moderate disease group and severe disease group had normal initial CXR.

For the initial CXR and the peak stage CXR, the most common parenchymal opacity was GGO, followed by mixed GGO and consolidation. In our study, mixed GGO and consolidation increased, especially in severe disease group, on the follow-up CXR at peak stage which is consistent with the previous study also showing frequent consolidation at peak stage[17]. Most patients showed multifocal and bilateral lung involvement, and lower zone predominance. These results are similar to previous studies[7-8, 15]. In term of transverse distribution, most patients had both central and peripheral distribution (48.6% on the initial CXR and 80% on the peak stage CXR). These results were different from previous studies, mostly CT findings, that most patients had peripheral distribution[7-8, 15]. This discrepancy may be because CXR provides two-dimensional (2D) image. Summation of the abnormalities that are located medially and peripheral in distribution on CT, may be projected as central on the CXR. Pleural effusion was uncommon which is consistent with previous studies[6-8, 16, 18]. In our study, pleural effusion was found only in severe disease group and all dead patients, so pleural effusion might increase risk for

severe disease. Mediastinal lymph node was uncommon which is consistent with previous studies[6-8]. In our study, mediastinal lymph node was shown in only one patient who had pulmonary tuberculosis, so mediastinal lymph node may be from existing pulmonary tuberculosis rather than COVID-19.

The initial CXR severity score and the peak stage CXR severity score in severe disease group were significantly higher than all other groups (p<0.001). The duration from initial symptoms to the peak stage CXR was 10.9±4.5 days which is consistent with finding that the severity of CXR peaked at 9-13 days[16-17].

Our study had some limitations. First, it was a retrospective study which may limit the follow-up CXR. Second, some of CXRs showed subtle abnormality.

Conclusion

CXR may be useful for initial assessment of COVID-19 patients. Patients in moderate and severe disease groups might have normal initial CXR. The most common CXR findings of COVID-19 pneumonia were ground glass opacity, multifocal and bilateral lungs involvement, both central and peripheral distribution and lower lung zone predominant. Pleural effusion was uncommon and presented only in severe disease group. The duration from initial symptoms to the peak stage CXR was around 11 days.

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