Original Article

Chest X-Rays Findings and Correlation to Clinical Severity in COVID-19 Patients

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Background: The manifestations of COVID-19 infection show a wide range of respiratory symptoms. Chest X-ray (CXR) is helpful for assessment, treatment, and monitoring hospitalization.

Objective: To describe and distinguish CXR findings of patients confirming COVID-19 with correlation to clinical severity.

Material and Methods: Between March and May 2020 all patients at Pattani provincial and field hospitals in Pattani Province with positive RT-PCR results for COVID-19 were retrospectively reviewed. Patients' demographics and clinical characteristics were evaluated and clustered in two groups based on clinical severity. Baseline CXRs were reviewed and correlated with clinical severity.

Results: Forty-eight patients, including 31 males (64.6%) males and 17 females (35.4%), were admitted with confirmed COVID-19. Their age ranged from 3 to 91 years (48.7±18.4 years). Fifteen (31.3%) of the cases had comorbidities. Forty-eight baseline CXRs were obtained, in which 25.0% (12) of CXRs showed abnormalities. The most common pattern and distribution on CXRs was patchy and/or confluent ground-glass opacities and peripheral subpleural distribution in 10/12 (83.3%). The non-severe group showed predominance in the lower lung zone in 4/5 (80%), while in the severe group, they showed multiple zones of lung involvement in 6/7 (85.7%). Bilateral lung involvement in 5/7 (71.4%) was most frequent in the severe group ($p<0.001$).

Conclusion: The most frequent abnormal pattern on CXRs in COVID-19 were patchy and/or confluent ground-glass opacities with peripheral subpleural distribution. The severe group showed bilateral and multiple lung zones involvement. The CXR findings of lung consolidation, perihilar distribution, bilateral, and multiple lower lung zone opacities, in conjunction with other zones of lung involvement suggested a higher risk of a patient developing severe manifestations of COVID-19.

Keywords: Chest X-ray; Coronavirus; COVID-19; SARS-CoV-2; Severity

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Since December 2019, a novel virus, named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), commonly called Coronavirus Disease 19 or COVID-19, first emerged as a pandemic from Wuhan, Hubei Province, China[1,2]. The first case in Thailand was recorded in January 2020. The manifestations of SARS-CoV-2 infection[3] range from mild respiratory symptoms to severe acute respiratory syndrome (ARDS)[1]. Currently, the real-time reverse transcription polymerase chain reaction (RT-PCR) is the diagnostic reference standard[4,5]. However, this serologic examination has limitation due to delayed results[4]. Radiological evaluation of patients with clinical epidemiological suspicion of COVID-19 is mandatory pending RT-PCR results for earlier evaluation of thoracic involvement, which is useful for monitoring hospitalized patients. Most hospitals in Thailand employ chest X-ray (CXR) as first-line[6], with faster results compared to RT-PCR, especially by using portable X-ray units that reduce the movement of patients, so minimizing the risk of cross-infection[7]. Pattani is one of the three southern border provinces in Thailand initially affected by the COVID-19 pandemic due to migration from neighboring countries. Therefore, the purpose of the

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present study was to review the CXR radiographic features of COVID-19 with correlation to clinical severity in all RT-PCR confirmed COVID-19 patients at Pattani provincial and field hospitals, to explore the potential benefits of CXR as an alternative rapid and ubiquitous clinical assessment tool.

Materials and Methods

Patients

The present study protocol was approved by the Ethics Committee of Pattani Hospital (reference number: 002/2564). The inclusion criteria of the present retrospective study were 1) the patients with confirmed SARS-CoV-2 infection by RT-PCR on nasopharyngeal swab specimens according to the international guidelines at Pattani Hospital and field hospital in Pattani Province between March 2020 and May 2020, and 2) the patients underwent baseline CXR at first day of admission and having complete medical records available on the hospital information system. The final outcome (severity) was defined as either a patient being discharged, or a hospitalized patient being transferred to tertiary care at an internal medicine department or field hospital for further treatment (Figure 1).

Subgrouping of patients

The patients were clustered into two groups based on clinical severity with Group 1 as Severe case with severe pneumonia, and Group 2 as Non-severe case with mild case or asymptomatic, or mildly symptomatic without pneumonia, and moderate case with mild pneumonia.

Severity[8]

1. Mild case is described as asymptomatic and mild symptomatic without pneumonia

1.1. Mild asymptomatic

1.2. Mild symptomatic without risk factors or comorbidities where patients were given a combination of two drugs during admission, 1) chloroquine or hydroxychloroquine, and 2) duranavir or ritonavir or azithromycin.

1.3. Mild symptomatic with risk factor or comorbidities where patients were given a combination of three drugs during admission 1) chloroquine or hydroxychloroquine, 2) duranavir or ritonavir, 3) azithromycin)

2. Moderate case is described as mild pneumonia, which was defined as minimal or focal infiltrates and O_2 saturation of 94% or more at room air without risk factors or comorbidities, where patients were given a combination of three drugs during admission, 1) hydroxychloroquine or chloroquine (double dose), 2) duranavir or ritonavir, and 3) azithromycin)

3. Severe case is described as severe pneumonia, which was defined as progressive, extensive, multifocal, or bilateral infiltration. The definition extended to extrapulmonary organ dysfunction, used of high-flow nasal cannula, requirements of using invasive or non-invasive ventilation for maintaining O_2 saturation of 90% or more in addition to the patient having risk factors or comorbidities and given a combination of four drugs during admission, 1) favipiravir, 2) hydroxychloroquine or chloroquine (double dose), 3) duranavir or ritonavir, and 4) azithromycin)

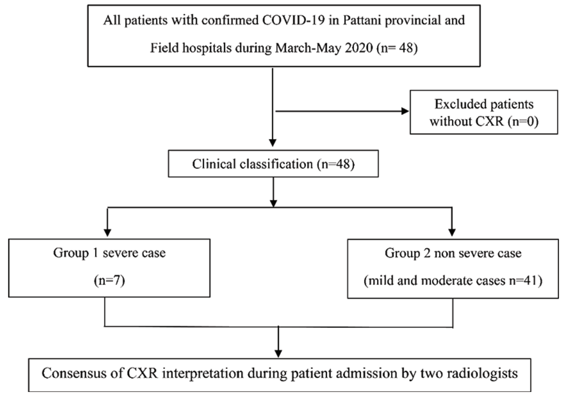

Figure 1. Study flow diagram demonstrated patients confirm COVID-19 clustered into two groups based on the clinical severity.

Comorbidities followed the guidelines for management of patients with confirmed COVID-19 updated on Mar 30, 2020, Department of Medical services, Ministry of Public Health of Thailand[8].

1. Old age more than 60 years
2. Chronic obstructive pulmonary disease (COPD) and other chronic lung diseases
3. Chronic kidney disease (CKD)
4. Cardiovascular disease and congenital heart diseases
5. Cerebrovascular diseases
6. Uncontrolled diabetes mellitus (DM)
7. Obesity with a BMI of 35 kg/m^2 or greater
8. Cirrhosis
9. Immunocompromised host with lymphocyte count of less than 1000 $cell/m^3$

Image acquisition and analysis

All the CXRs were acquired as digital radiographs most commonly via portable X-ray units in the isolation wards following local protocols. CXRs were performed in the postero-anterior or antero-posterior projection. All images were stored in a picture archiving and communication system (PACS). An independent and retrospective review of each CXR was performed by two radiologists with 10 and 15 years of experience, respectively. In case of discordance, a consensual agreement was reached.

- The radiographic features of patterns were diagnosed according to the Fleischner Society's nomenclature, available in the glossary of term for thoracic imaging[9].

- Consolidation[9]: Consolidation appear as a homogenous increase in pulmonary parenchymal attenuation that obscures the margins of vessels and airway wall. An air bronchogram may be present.

- Ground-glass opacity (GGO)[9]: Ground-glass opacity appear as an area of hazy increased lung opacity, usually extensive, within which margins of pulmonary vessels may be indistinct.

- Reticular opacity[9]: A collection of innumerable small linear opacities that, by summation, produce an appearance resembling a net.

- The location of lung patterns distribution was classified into 1) Perihilar distribution (central predominant), or 2) Peripheral subpleural distribution. Demarcation was defined as halfway between lateral edge of the lung and the hilum.

- The lung zone predominance was categorized by a frontal CXR into three zones per lung. The upper zone extended from the apices to the superior portion of the hilum. The mid zone spans the space between the superior and inferior hilar margins. The lower zone extended from the inferior hilar margins to the costophrenic sulci[10].

- The affected lung was classified as unilateral or bilateral.

Statistical analysis

Statistical analyses and estimated sample size for two-sample comparison of proportions were performed using Stata, version 12.1 (StataCorp LP, College Station, TX, USA). The authors calculated a sample size of 48 patients would provide 80% power to detect an effect of a radiological finding in patients with severe pneumonia at a 5% significance level (two-sided). The mean and standard deviation (SD) were used to characterize continuous data. The number of occurrences and percentage in each cluster were used to calculate the frequency of radiographic findings. Fisher's exact test was used to compare the frequencies of the different groups (for categorical data). Results are presented as a risk difference (RD) obtained by multivariable risk regression analysis, adjust confounders by using prognostic score that included age, gender, and comorbidity with the corresponding 95% confidence interval (CI). Additionally, the predictive contribution of the radiographic findings was presented with receiver operating characteristic (ROC) areas. A statistically significant p-value less than 0.05 was used.

Table 1. Patients' demographic, characteristics, comorbidity disease, clinical presentation, and clinical outcome

Characteristics	Severe (n=7)	Non-severe (n=41)
Sex; n (%)		
Male	5 (71.4)	26 (63.4)
Female	2 (28.6)	15 (36.6)
Age (year); mean±SD	64.7±10.3	45.9±18.2
Comorbidity (any); n (%)	6 (85.7)	9 (21.9)
COPD and other chronic lung disease (asthma)	1 (14.3)	0 (0.0)
CKD	1 (14.3)	0 (0.0)
HT	2 (28.6)	6 (14.6)
Uncontrolled DM	3 (42.9)	4 (9.8)
Cardiovascular and congenital heart disease	0 (0.0)	1 (2.4)
Cerebrovascular disease	0 (0.0)	1 (2.4)
Clinical presentation; n (%)		
Asymptomatic	0 (0.0)	27 (65.9)
Symptomatic	7 (100)	14 (34.2)
Clinical outcomes; n (%)		
Discharged with improvement	5 (71.4)	41 (100)
Transfer to tertiary care hospital	1 (14.3)	0 (0.0)
Died	1 (14.3)	0 (0.0)

SD=standard deviation; COPD=chronic obstructive pulmonary disease; CKD=chronic kidney disease; HT=hypertension; DM=diabetes mellitus

Results

Patient characteristics

Forty-eight patients including 31 males (64.6%) and 17 females (35.4%) were hospitalized with RT-PCR confirmed COVID-19. The average age was 48.7±18.4 years with a range of 3 to 91 years. Fifteen cases (31.3%) had comorbidities such as hypertension (HT), uncontrolled DM, asthma, tuberculosis (TB), CKD, and stroke while 33 cases (68.7%) had no comorbidities. Twenty-seven cases (56.3%) had no symptoms while 21 cases (43.7%) had symptoms. However, the patients in the severe group had comorbidities in 85.7% of the cases or in 6/7 cases and 100% had symptoms of the disease thus 7/7 cases. Table 1 shows patients' demographics, characteristics, comorbidities, clinical presentation, and clinical outcome.

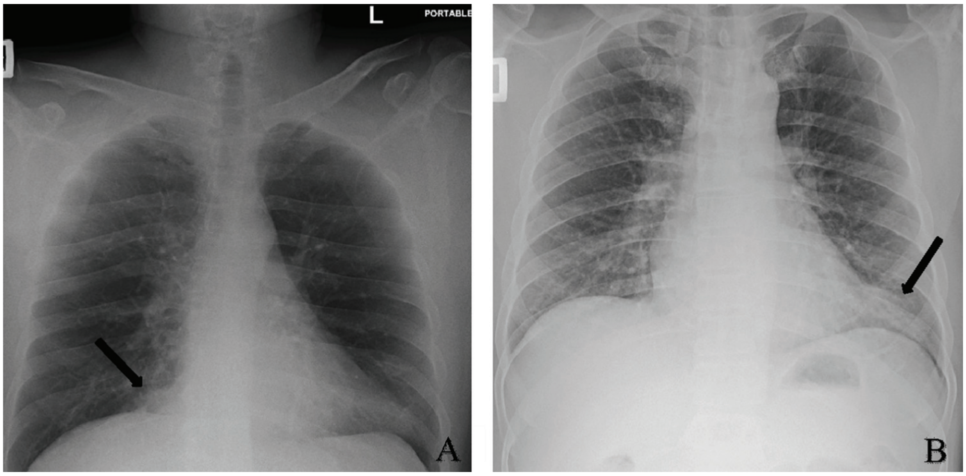

Figure 2. (A) A36-year-old male patient was diagnosed of COVID-19, categorized into the non-severe group with a baseline CXR showing patchy ground-glass opacity at the right lower lung zone. (B) A 48-years old male patient without underlying disease was diagnosed of COVID-19, classified as non-severe with a baseline CXR showing patchy ground-glass opacity at the left lower lung zone.

Chest radiography evaluation

Forty-eight baseline CXRs were obtained from 48 patients, of which 36 (75.0%) CXRs were negative for radiological thoracic involvement and 12 (25.0%) of the CXRs showed abnormalities. The most common abnormal pattern on CXRs were patchy and/or confluent ground-glass opacities in 10/12 (83.3%) ($p<0.001$). The other abnormal patterns found were bandlike ground-glass opacity in one CXR and consolidation also in one CXR. The most frequently seen distribution of pattern abnormalities was peripheral subpleural distribution in 10/12 (83.3%) ($p<0.001$) and perihilar distribution in 2/12 (16.7%). The non-severe group showed lower lung zone predominance in 4/5 (80%) while the severe group showed more than one lung zone involvement in 6/7 (85.7%). Moreover, bilaterally affected lung involvement in 5/7 (71.4%), which was seen more frequently than unilateral involvement at 2/7 (28.6%) in the severe group ($p<0.001$). Table 2 shows radiographic findings.

Table 2. Radiographic findings

Findings	Severe (n=7); n (%)	Non-severe (n=41); n (%)	p-value (Fisher's exact test)
Feature of patterns			<0.001
Normal	0 (0.0)	36 (87.8)	
Consolidation	1 (14.3)	0 (0.0)	
Patchy and/or confluent GGO	5 (71.4)	5 (12.2)	
Bandlike GGO	1 (14.3)	0 (0.0)	
Location of distribution			<0.001
Normal	0 (0.0)	36 (87.8)	
Peripheral subpleural	5 (71.4)	5 (12.2)	
Perihilar	2 (28.6)	0 (0.0)	
Lung zones predominant			<0.001
Normal	0 (0.0)	36 (87.8)	
Lower	1 (14.3)	4 (9.8)	
Upper & middle	1 (14.3)	1 (2.4)	
Middle & lower	2 (28.6)	0 (0.0)	
Upper & lower	1 (14.3)	0 (0.0)	
Upper & middle & lower	2 (28.6)	0 (0.0)	
Affected lung			<0.001
Normal	0 (0.0)	36 (87.8)	
Unilateral	2 (28.6)	3 (7.3)	
Bilateral	5 (71.4)	2 (4.9)	

GGO=ground glass opacity

Chest radiography evaluation of subgroups

In the non-severe group, the authors found abnormal CXRs in about 12.2% (5/41 cases). All cases with pattern abnormalities showed patchy ground-glass opacities and peripheral subpleural distributions. Most cases showed lower lung zone predominance in 4/5 (80.0%) and unilateral lung involvement was more common than bilateral lung involvement (Figure 2).

All cases belonging to the severe group showed abnormal CXRs at 100% (7/7 cases) ($p<0.001$). The most frequently found abnormal patterns were patchy and/or confluent ground-glass opacities in 5/7 (71.4%) and other abnormal patterns including bandlike ground-glass opacity and consolidations. The peripheral subpleural distribution of abnormal patterns in 5/7 (71.4%) were mostly found in the severe group. Most cases in the severe group showed

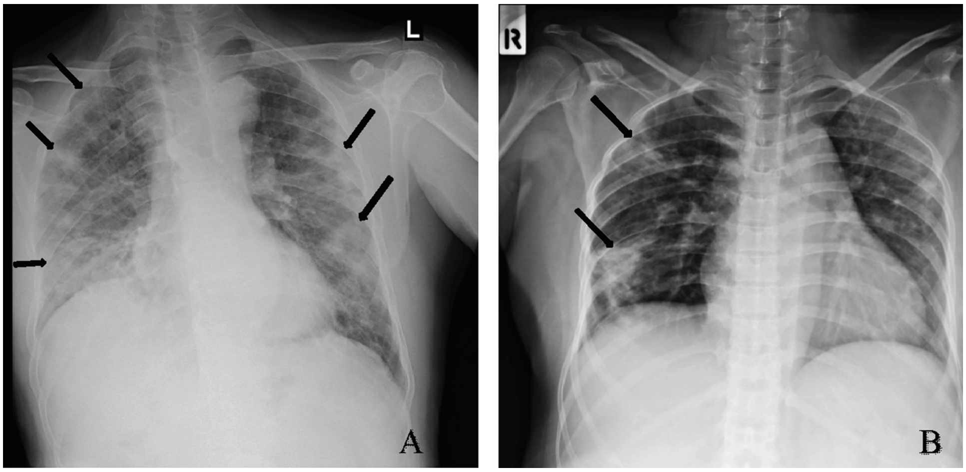

Figure 3. (A) A 68-year-old male patient with underlying HT, gout, DLP, and CKD stage 3 was diagnosed with COVID-19, categorized into the severe group with a baseline CXR showing multifocal patchy or confluent ground-glass opacities at bilateral peripheral subpleural distribution of upper, middle, and lower lung zones. (B) A 50-year-old female patient with underlying DM was diagnosed with COVID-19 classified as severe, with a baseline CXR showing consolidations at the peripheral subpleura at right upper and right lower lung zones.

more than one lung zone involvement in 6/7 (85.7%) in varying combinations ranging from upper and middle lung zones, middle and lower lung zones, upper and lower lung zones, in addition to cases with upper, middle, and lower lung zone involvement (Figure 3). Bilateral lung involvement was mostly found in the severe group in 5/7 (71.4%). Table 2 shows radiographic findings.

Effect of radiological findings on risk of severity

Patients whose CXR showed radiographic findings discussed in the present study were shown to have varying effects on the risk of developing increased disease severity as described below (Table 3).

Feature of patterns: Patients whose CXR showed consolidation patterns had a higher risk to belong to the severe group compared to the patient with normal CXR, 74.0% (95% CI 61 to 86, p<0.001). Similarly, patients whose CXR showed bandlike ground-glass opacities had a higher risk to belonging to the severe group compared to the patient with normal CXR, 65.0% (95% CI 49 to 81, p<0.001), while patients whose CXR showed patchy and/or confluent ground-glass opacities had a lowest risk to belong to the severe group compared to the patient with normal CXR, 32.0% (95% CI 5 to 59, p=0.018).

Location of distribution: If CXRs of the patients with confirmed COVID-19 showed perihilar distribution, the authors found the patient had a higher risk to belong to the severe group than the patient with a normal CXR, 52.0% (95% CI 24 to 80, p<0.001). Furthermore, patients whose CXR showed peripheral subpleural distribution had a higher risk to belong to the severe group compared to the patients with normal CXR, 36.0% (95% CI 9 to 63, p=0.008).

Lung zones predominant: If CXRs of the patients with confirmed COVID-19 showed abnormal opacities in lower lung zone together with the other

Table 3. Effect of radiological findings on risk of severity*

Radiological characteristics	Effect (%)	95% CI	p-value
Feature of Patterns			
Consolidation	74	61 to 86	<0.001
Patchy and/or confluent GGO	32	5 to 59	0.018
Bandlike GGO	65	49 to 81	<0.001
Location of Distribution			
Peripheral subpleural	36	9 to 63	0.008
Perihilar	52	24 to 80	<0.001
Lung zones predominant			
Lower	12	–2 to 27	0.096
Upper & middle	30	–26 to 85	0.290
Middle & lower	79	60 to 99	<0.001
Upper & lower	92	85 to 99	<0.001
Upper & middle & lower	64	32 to 97	<0.001
Affected lung			
Unilateral	20	–1 to 43	0.064
Bilateral	49	15 to 83	0.004

GGO=ground glass opacity; CI=confidence interval

* Compared to normal CXR

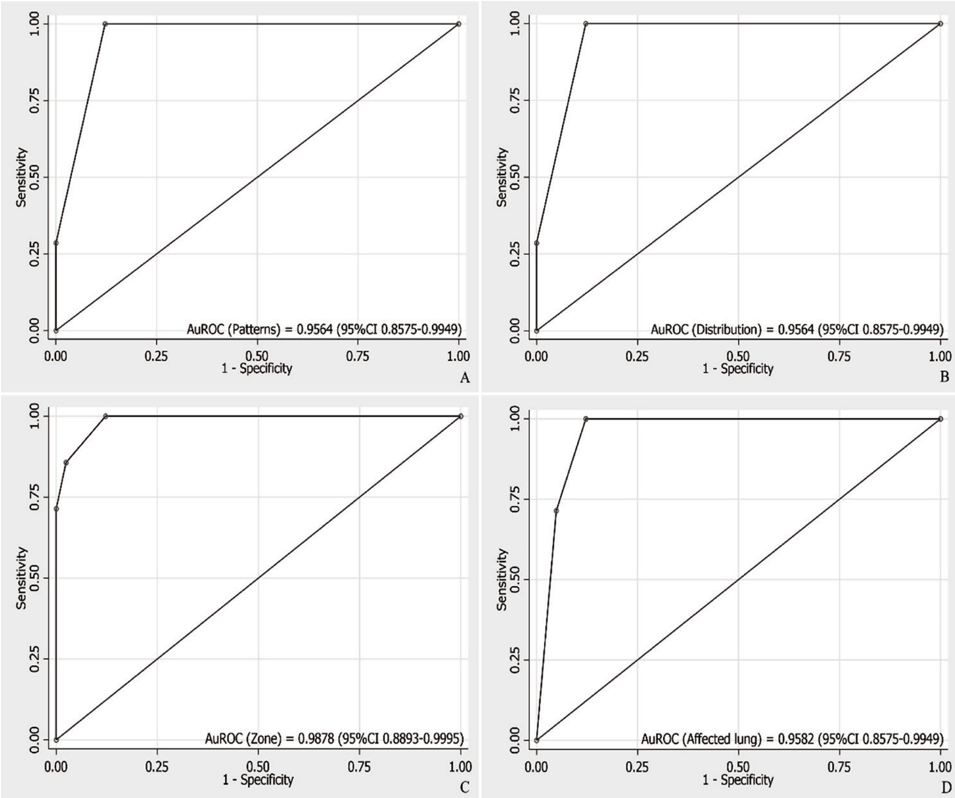

Figure 4. The predictive contribution of the radiographic findings to distinguish clinical severity. (A) Feature of patterns, (B) Location of distribution, (C) Zone of lung pattern predominance, (D) Laterality of affected lungs.

lung zone involvement, they had a higher risk to belong to the severe group than the patient with a normal CXR, 64.0% to 92.0% (95% CI 32 to 99, p<0.001).

Affected lung: Bilateral lung opacities had a higher risk to belong to the severe group than a normal CXR, 49.0% (95% CI 15 to 83, p=0.004).

Predictive contribution of the radiographic findings to distinguish clinical severity

The predictive contribution of the radiographic findings to distinguish clinical severity was presented with ROC areas (Figure 4). The ROC area's feature of patterns, location of distribution, zone of lung pattern predominance and laterality of affected lungs showed 0.9564 (95% CI 0.8575 to 0.9949), 0.9564 (95% CI 0.8575 to 0.9949), 0.9878 (95% CI 0.8893 to 0.9995), and 0.9582 (95% CI 0.8575 to 0.9949), respectively. The zone of lung pattern predominance showed the highest AUROC (area under ROC) suggesting that radiographic findings had the greatest ability in distinguishing clinical severity in lungs affected by COVID-19. The feature of patterns and location of distribution showed similar abilities in distinguishing clinical severity in lungs affected by COVID-19.

Discussion

The authors analyzed the abnormal CXRs findings in terms of opacity pattern, opacity distribution, lung zone predominance of opacities, and affected lung involvement as unilateral or bilateral, which were correlated with clinical severity.

Twelve (25.0%) of CXRs in the 48 confirmed COVID-19 patients showed abnormalities. In the severe group, the authors found abnormalities in 100% (7/7) of CXRs, while in the non-severe group the authors found abnormalities in only 12.2% (5/41) of CXRs, reflecting its low sensitivity in detecting early or mild pneumonia. The patterns of abnormal CXRs were bandlike ground-glass opacities, patchy and/or confluent ground-glass opacities, and consolidations. The most common abnormal patterns on CXRs were patchy and/or confluent ground-glass opacities in 10/12 (83.3%). The most common distribution pattern abnormalities were seen in the peripheral subpleura in 10/12 (83.3%). In the non-severe group, the lower lung zone showed predominance in 4/5 (80%), while in the severe group, various combinations of predominance involving more than one lung zone were seen in 6/7 (85.7%), ranging from lower lung zone involvement, middle and lower lung zones, upper and lower lung zones, and the cases with upper, middle and lower lung zone involvement. Moreover, bilateral affected lung involvement in 5/7 (71.4%) was more frequently seen than unilateral lung involvement in 2/7 (28.6%) in the severe group.

The author's findings were in line with Rousan et al[11], who did a study on 88 COVID-19 patients in Jordan, found ground glass opacities and consolidation patterns, but their study found ground glass opacities were more than consolidation. In addition, peripheral predominance was seen in CXR abnormalities with lower zone distribution. Cozzi et a1[4], which reported patchy or diffuse reticular-nodular opacities and consolidation, with basal, peripheral, and bilateral predominance in their study 234 COVID-19 patients in Italy. Yasin et al[12], performed a study on 350 patients of COVID-19 disease in Egypt and they found that consolidation was the most common finding in 81.3% with bilateral lung infection in 67.5%, with peripheral distribution in 58.2%, and lower zone involvement in 73.1%. Vancheri et al[1], performed a study on 240 patients with COVID-19 pneumonia in Italy. The most frequent lesions in COVID-19 patients were ground glass opacities for intermediate or late phase, and reticular alteration for early phase, while consolidation gradually increased over time. The most frequent distribution was bilateral, peripheral, and with middle or lower predominance. Smith et al[13], performed a study on 366 patients with confirm COVID-19 by RT-PCR tests in New Orleans, they found that the presence of patchy and/or confluent, bandlike ground-glass opacity, or consolidation in a peripheral and mid to lower lung zone distribution on a chest radiograph obtained in the setting of pandemic COVID-19 was highly suggestive of severe acute respiratory syndrome coronavirus 2 infection and should be used in conjunction with clinical judment to make a diagnosis.

The authors analyzed the effect of radiological findings on the risk of developing disease severity (Table 3). Patients whose CXR showed consolidation patterns had the highest risk to belonging to the severe group compared to the patient with normal CXR, 74.0% (95% CI 61 to 86, $p<0.001$). This was due to the consolidation, which was mostly a dense opacity representing the most active pulmonary disease and severe pathological lesion. The authors also found that if the CXR of patients with confirmed COVID-19 showed abnormal opacity in the lower lung zone together with other lung zone involvement, these patients carried a higher risk to belonging to the severe group compared to the patient with a normal CXR, 64.0% to 92.0% (95% CI 32 to 99, $p<0.001$). An explanation for such findings may be that in the early stages of the non-severe group, most cases showed lower lung zone predominance, when the infection progresses into the severe group. The authors found that lower lung zone involvement together with other lung zones, in addition to bilateral lung involvement, which reflected the extensive area of destroyed lung tissue related to clinical symptom severity was related to the higher risk to belonging to the severe group than the patients with a normal CXR, 49.0% (95% CI 15 to 83, $p=0.004$). Large areas of lung opacities suggested the presence of extensive destroyed lung tissue and subsequently decreased remaining normal lung tissue left to maintain gas exchange for a functional respiratory system, resulting in worsening clinical symptoms, and disease severity.

Moreover, the predictive contribution of the radiographic findings to distinguish clinical severity was presented with ROC areas. The zone of lung pattern predominance showed the highest AUROC suggesting this radiographic finding had the greatest ability in distinguishing clinical severity in lungs affected by COVID-19.

The other findings, such as pleural effusion, pneumothorax, or lung cavity were not found in the present study, corresponding with most studies that showed rare findings in CXRs of COVID-19 patients[14,15].

However, the limitation of the present study was a small sample size in early stages of the outbreak. Therefore, the interpretation of these results was limited and might not represent all COVID-19 patients.

In the present study, the authors had one case where a patient from the severe group died due to refusal of intubation. This patient was older than 60 years and had no underlying disease. The patient had a baseline CXR that showed patchy and confluent ground-glass opacities at bilateral middle and lower lung zones. The follow up CXR two days later found consolidations at bilateral middle and lower lung zones (Figure 5).

Another case in the severe group was referred to tertiary care hospital due to progressive pneumonia. The patient was younger than 60-years but had

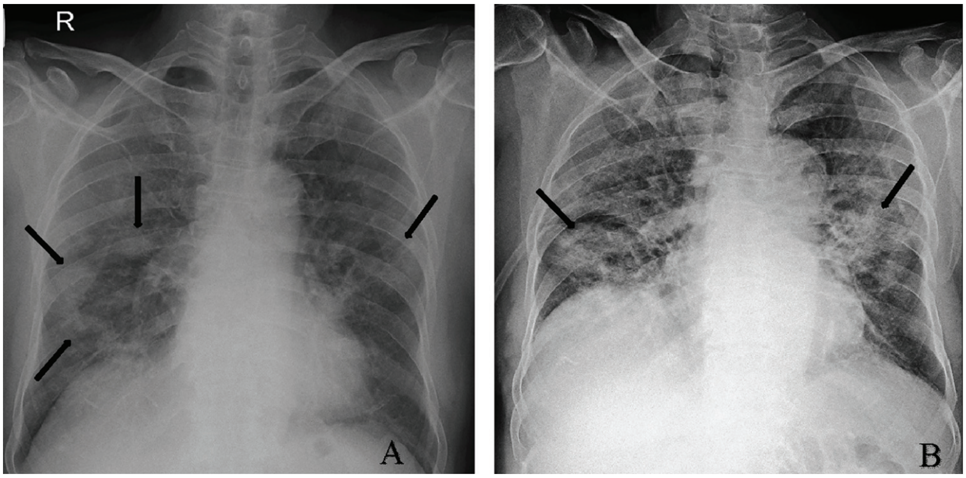

Figure 5. A 77-year-old male patient without underlying disease was diagnosed of COVID-19, categorized into the severe group, had died due to refusal of intubation. (A) The baseline CXR showed patchy and confluent ground-glass opacities at bilateral middle and lower lung zones. (B) The follow up CXR two days later found consolidations at bilateral middle and lower lung zones.

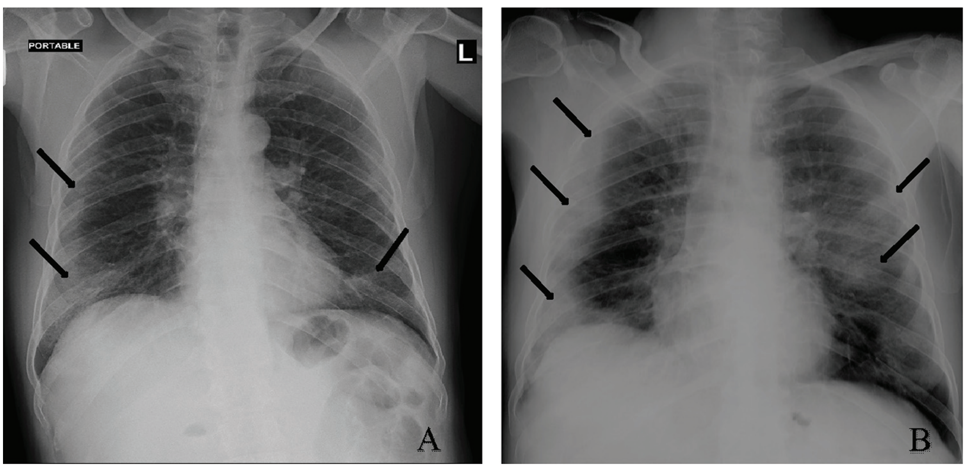

Figure 6. A 55-years old male patient with underlying diabetes mellitus was diagnosed of COVID-19, categorized into the severe group and developed progressive pneumonia, the patient was subsequently referred to tertiary care hospital. (A) The baseline CXR showed bandlike ground-glass opacity at peripheral subpleural distribution of right middle and lower lung zones. (B) The follow up CXR in three days later also found consolidations at bilateral middle and lower lung zones.

underlying diabetes mellitus. The baseline CXR showed bandlike ground-glass opacity at peripheral subpleural distribution of right middle and lower lung zones. The follow up CXR three days later also found consolidations at bilateral middle and lower lung zones (Figure 6).

Lastly, a 71-year-old male patient with underlying diabetes mellitus was diagnosed of COVID-19 by RT-PCR for SAR CoV-2. The baseline CXR showed patchy or confluent ground-glass opacities at right middle and upper lung zones suggesting a typical pattern of pulmonary tuberculosis in this endemic area. During treatment of COVID-19, the Gene X-pert MTB from sputum was detected at high level. Therefore, both diseases were simultaneously treated. The follow up CXR a week later showed decreased opacities at right middle and upper lung zones (Figure 7). COVID-19 pneumonia and pulmonary TB could co-exist. Co-infections might cause misinterpretation of baseline CXR. In the event that the patient was confirmed COVID-19 by RT-PCR detected SAR CoV-2, but baseline CXR showed abnormal opacities involved the upper lung zone, pulmonary TB should be simultaneously investigated. COVID-19 pneumonia could improve on CXR in subsequent weeks, but pulmonary TB lesion could

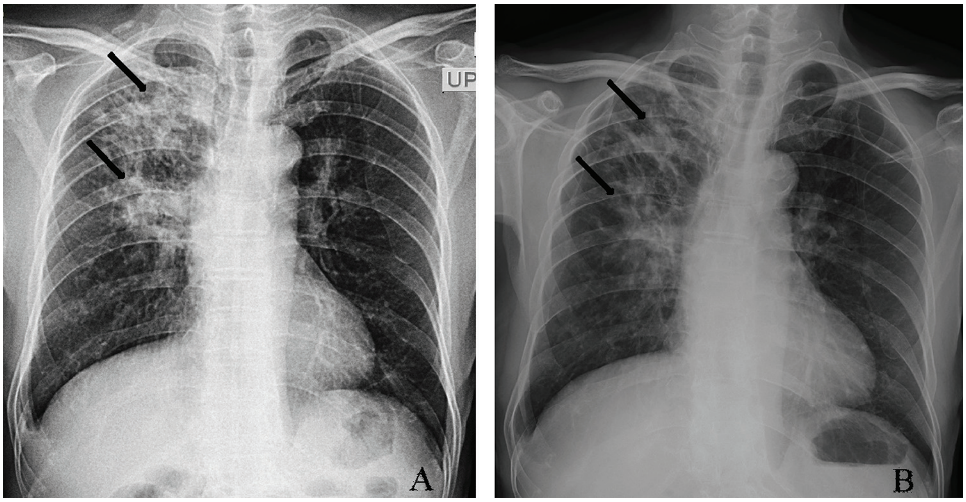

Figure 7. A 71-year-old male patient with underlying diabetes mellitus was diagnosed of COVID-19 by RT-PCR for SAR CoV-2, and the Gene X-pert MTB from sputum was highly positive. (A) The baseline CXR showed patchy or confluent ground-glass opacities at right middle and upper lung zones. (B) The follow up CXR in the subsequent week after treatment COVID-19 and start of antituberculous drugs resulted in decreased opacities at right middle and upper lung zones.

remain on CXR even after complete treatment.

Conclusion

The most frequent abnormal pattern on CXRs in COVID-19 were patchy and/or confluent ground-glass opacities with peripheral subpleural distribution. The severe group showed bilateral and multiple lung zones involvement. The CXR findings of lung consolidation, perihilar distribution, bilateral and multiple lower lung zone opacities, in conjunction with other zones of lung involvement suggest a higher risk of a patient developing severe manifestations of COVID-19.

What is already known on this topic?

Pattani is one of three southern border provinces in Thailand initially affected by the COVID-19 pandemic.

In many countries, various CXRs findings of COVID-19 patients have been reported but the available data in Thailand is controversial about CXRs findings of COVID-19 patients, and it is equivocal about CXRs findings to predict the severity of the disease.

What this study adds?

The authors found various CXRs findings of COVID-19 patients consistent with the data in several countries. However, the most frequent abnormal pattern on CXRs in this COVID-19 study was patchy and/or confluent ground-glass opacities with peripheral subpleural distribution.

In addition, the CXR findings of lung consolidation, perihilar distribution, bilateral and multiple lower lung zone opacities, in conjunction with other zones of lung involvement suggest a higher risk of developing severe manifestations of COVID-19. Therefore, these indicated the prognosis of disease during treatment and monitoring patients.

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Conflicts of interest

The authors declare no conflict of interest in this research.

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