

Diagnosis and Treatment of Severe COVID-19 Complicated with Spontaneous Pneumothorax: A Case Report

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Abstract: This case report describes a patient with severe coronavirus disease 2019 (COVID-19) concomitantly with spontaneous pneumothorax, along with retrospective analysis of effective diagnosis and treatment. The case shows how chest radiography and computed tomography can play an important role in diagnosing and providing useful information for clinical management. The patient's outcome and prognosis was related to his clinical management. In particular, early comprehensive treatment was certainly key to reducing complications and mortality in severe novel coronavirus pneumonia.

Key words: COVID-19; Spontaneous pneumothorax; CT scan; Diagnosis; Treatment.

Advanced Ultrasound in Diagnosis and Therapy 2020;02:142-146

DOI: 10.37015/AUDT.2020.200019

Coronavirus is a type of enveloped RNA virus that is widely distributed in humans, other mammals, and birds. The infection of coronavirus can cause respiratory, intestinal, liver, and nervous system diseases [1,2]. A group of patients with unexplained pneumonia were reported in December 2019, all of whom had exposure in the wholesale seafood market at Wuhan, China. When these patients were tested, unbiased sequencing of samples from the patients with pneumonia detected a previously unknown β coronavirus that was afterwards named SARS-CoV-2. Here, we present a case report for a patient with severe coronavirus disease 2019 (COVID-19) concomitantly with spontaneous pneumothorax along with analysis of effective diagnosis and treatment retrospectively.

Case study

Patient characteristics

The patient was a 38-year-old man, 180cm height, and 82 kg weight. He complained of fever for 11 days and cough for 3 days. Though he claimed no history

of interaction with the South China seafood market, however, he had a meal with colleagues recently. The patient smoked and drank for years and was allergic to levofloxacin. Physical examination found the following: body temperature 37 °C, heart rate 85 beats/min, breathing 22 beats/min, blood pressure 130 / 80mmHg, and finger oxygen saturation 87% (without oxygen inhalation). Chest radiographs were performed on January 16, January 27, and February 8. (Fig. 1A). Blood analysis was normal and influenza virus test was negative. The patient was admitted to the hospital on January 22, 2020.

Diagnosis and treatment

On admission, the patient was provided continuous nasal inhalation of oxygen. On January 24, the nucleic acid test of his throat swab was positive. One day later, the patient showed dyspnea at night, so a high-flow nasal canula (temperature 31° C, flow 50 L/min, oxygen concentration 80%) was administered. Patient symptoms were alleviated subsequently, and the SPO2 increased to 91%.

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But on January 26, the patient's biochemical indicators changed (Table 1), and the chest radiograph showed double lung membrane vitreous shadow (Fig. 1B). Thus, the antivirals (ganciclovir, oseltamivir) and hormones were replaced with abidol (0.2 g, p.o., TID), and meropenem (1.0 g, IVGTT, Q 12 h) plus azithromycin (0.25 g, p.o., Q d). Medications that promote the absorption of inflammatory factors (50 ml, xuebijing, IVGTT, Q 12 h), phlegm and antifibrosis (acetylcysteine effervescent, Jinkang Suoli, 0.6 g, p.o., TID) were prescribed as well.

The patient's signs were mostly stable from January 26 to February 1, and the nucleic acid test of his throat swab was negative on January 31. However, on February 4 the patient complained of pain in his right anterior chest, with an aggravated irritating dry cough. Meanwhile, palpitation and dyspnea occurred after minor activity. Therefore, the biochemical indicators (Table 1), chest radiograph (Fig. 1C), and chest CT

were re-examined. Compared the admission CT (Fig. 2A), the CT (Fig. 2B) showed the lung infection had worsened and lung tissue was compressed by 30%. The treatment methods were adjusted accordingly, including reducing activity, adjusting parameters of oxygen inhalation, prescribing anti-infection medication (piracillin sodium 2.5 g, Yijun, IVGTT, Q 12 h), reintroducing methylprednisolone sodium succinate and doxofylline infusion to relieve hyperresponsiveness, adding long-acting beta-receptor agonist plus hormone inhalant (salmeterol tikasone, sulide, 50/500 µg), and preventing deep vein thrombosis (Enoxaparin Sodium, Kesai, 4000 u, subcutaneous injection). Although the nucleic acid test of pharyngeal swab was positive on February 6, three consecutive subsequent re-examinations of the nucleic acid test were negative on February 14, 19, and 22. The chest CT results showed significant improvement (Fig. 2C). Then the patient was discharged on February 24.

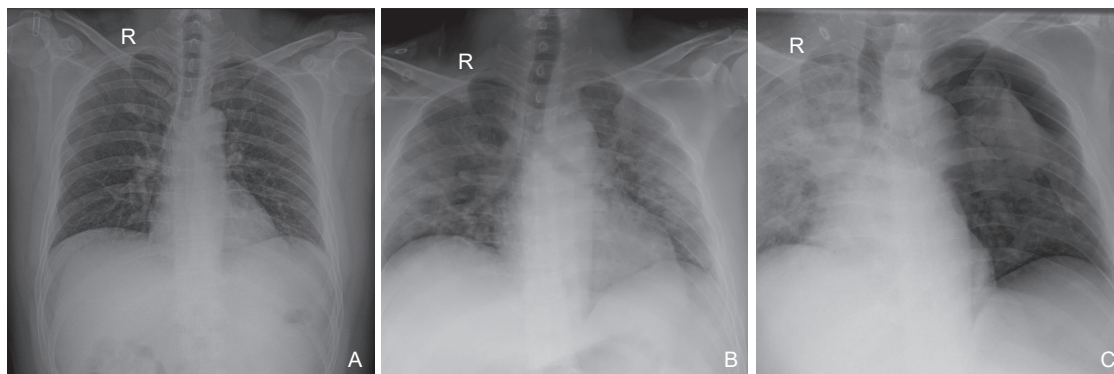


Figure 1 Chest X-ray findings. (A) On January 16, the texture of both lungs was enhanced and blurred, and it was recommended to re-examine after treatment; (B) On January 27, the texture of both lungs became thicker, increased, blurred, and the patch-like blur was seen in the outer band of the lesion; bilateral hilar flocculation, suggesting infectious lesions in both lungs, and possible viral pneumonia; (C) On February 8, the texture of both lungs became thicker and thicker, scattered in patchy and flocculent blurs, with blurred edges, and the left lung field tissue was compressed by about 30%; considering the left pneumothorax, bilateral lung infection, and the lesions progressed.

Discussion

The coronavirus disease 2019 (COVID-19) is an acute respiratory infectious disease caused by SARS-CoV-2. The types of novel coronavirus pneumonia (NCP) that it causes are classified as light, normal, severe, and critical, according to the disease severity. Patients with COVID-19 mainly manifest with fever, cough, and dyspnea [3]. Severe patients usually present with dyspnea and/or hypoxemia after 1 week of onset, and progress rapidly to acute respiratory distress syndrome and coagulation dysfunction [4]. The patient in this present case report showed that as the bilateral lung infection became gradually aggravated on CT (Fig. 1, 2), indicators of laboratory examination (Table 1) further suggested the same progression, with myocardial and liver damage as well.

This patient was diagnosed with severe NCP based on epidemiology, clinical symptoms, imaging, and nucleic acid test. After admission, he presented with acute hypoxic respiratory failure, and the oxygenation index was less than 200. He was given high-flow nasal canula (HFNC), which was better adaptable to him compared with the ordinary non-invasive ventilator [5]. However, the patient developed spontaneous pneumothorax, which might be related to deep airway and alveolar damage caused by COVID-19 virus infection, especially the distal alveoli with mucus-like exudation [6]. The pathology of NCP mainly shows the exudation of monocytes and macrophages, vascular congestion, and edema in the alveolar septum, with the formation of transparent thrombus in the blood vessels [7]. Based on pulmonary fibrosis caused by inflammation, bronchioles

are narrow and distorted, and the valve mechanism could cause pulmonary bullae. Increased intrapulmonary pressure, such as coughing, may lead to bullae rupture and secondary pneumothorax. Continuous use of HFNC can increase PO₂ in the blood and decrease the nitrogen pressure (P_N). Increasing the P_N difference between the pleural cavity and the blood will help the transfer of nitrogen from the pleural cavity to the blood, and accelerate lung recruitment consequently (Fig. 2F)

[8]. For the patient with refractory and irritating dry cough, the dry-powder inhaler (DPI), or the quantitative inhalation combined with aerosol storage tank (long-acting β 2 receptor agonist) plus hormone (sulide, 50/500 μ g) may reduce the airway hyperresponsiveness and improve airway spasm [9]. Acetylcysteine effervescent is beneficial for pulmonary rehabilitation due to its antioxidant, anti-inflammatory and immunomodulatory effects, as well [10].

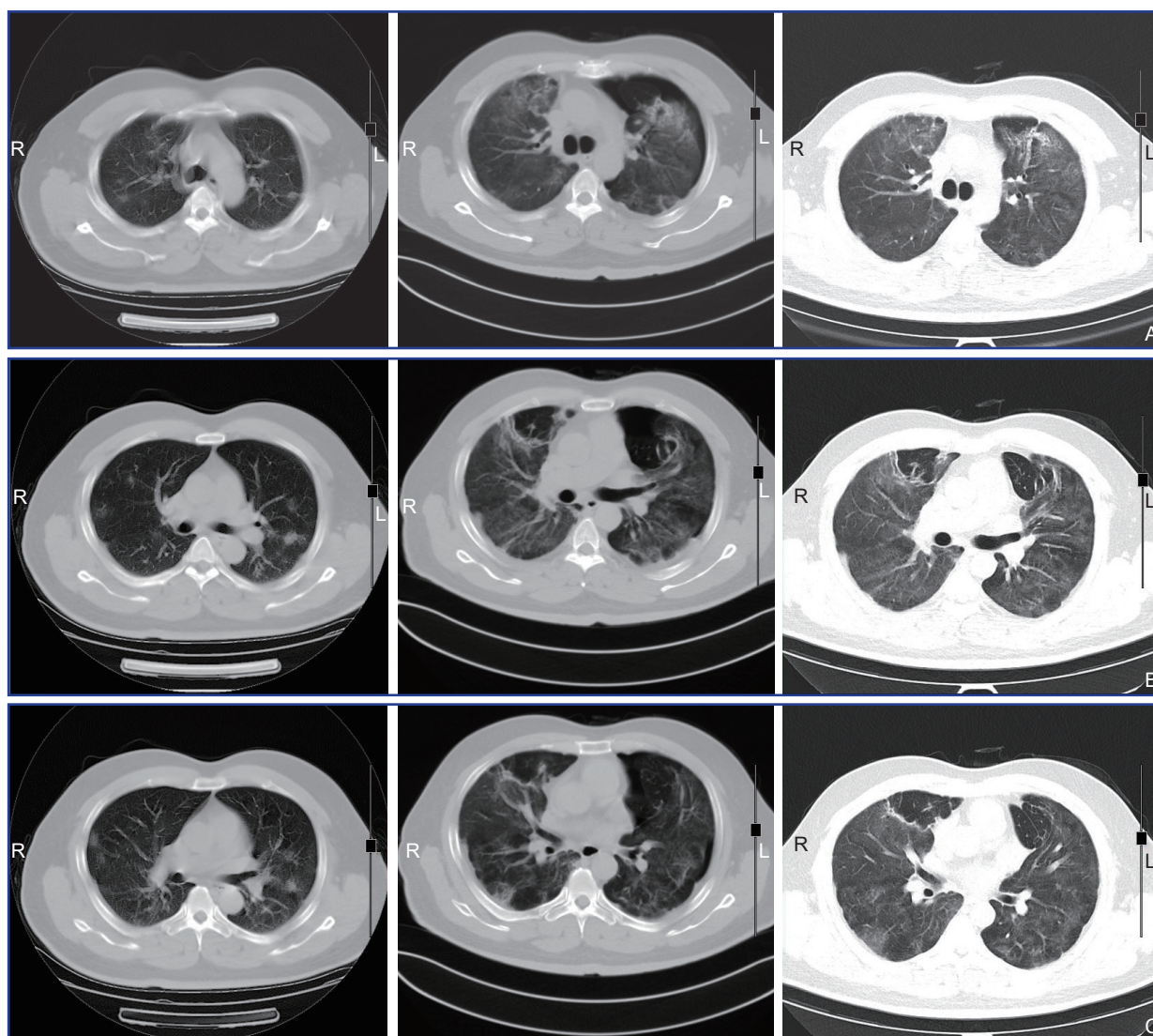


Figure 2 Chest CT findings. (A) On January 18, the bilateral lung field had normal brightness and increased lung texture, considering bilateral pneumonia; (B) On February 15, the texture of bilateral lungs became thicker, increased, and blurred, scattered in patchy, flocculent blurry shadows, with blurred edges, left pneumothorax, lung tissue compression by 30%, and bilateral lung infection; (C) On February 21, bilateral lung texture was enhanced, and both lungs became brighter. Patches of the lungs were scattered under the pleura and patchy indistinct shadows. The lesions improved, bilateral emphysema and bilateral alveoli, the lateral pneumothorax has improved substantially.

Several useful lessons could be obtained from the diagnosis and treatment of this case. Firstly, the cluster-onset is the main incentive (colleagues occurred who dined together developed similar symptoms). Secondly, some long-term lifestyle behaviors may increase

susceptibility to the infection. Thirdly, the main signs and symptoms include fever, irritating dry cough, fatigue and dyspnea. Fourth, arterial blood gas analysis indicated acute respiratory failure, and 2019-nCoV nucleic acid test was positive in respiratory secretions.

As the disease worsens, multiple ground-glass-like lung may be observed, and are more predominant in the extrapulmonary bands [7], and even concomitant pneumothorax. Last, HFNC provides stable and high oxygen concentration to improve oxygenation compared with non-invasive ventilator. Reaching or exceeding the patient's maximum inspiratory flow rate of active inhalation could reduce inhalation resistance, respiratory burden, and oxygen consumption. Humidification reduces the consumption of heat and water in patients with respiratory distress, maintains

the airway mucous ciliary function at an optimal state, and facilitates drainage of secretions. It also provides a certain level of positive airway pressure and opens alveoli to prevent infections. In addition, HFNC does not require a completely closed circuit or exert obvious facial pressure, thus patient compliance is satisfactory. In addition, administration of high airflow washes the dead cavity of the upper airway to improve patient ventilation [11] and promote lung recruitment in ways that could efficiently benefit patients.

Table 1 Laboratory test results

Item/Date	January 22	January 26	January 29	February 04	February 08	February 13
Leukocyte count ($\times 10^9/L$)	6.69	14.43	13.03	9.12	11.9	9.57
Blood platelet ($\times 10^9/L$)	198.00	278.00	284.00	255.00	319.00	455.00
Neutrophilic leukocytes (%)	80.60	91.40	86.60	79.00	76.30	54.70
Lymphocyte ($\times 10^9/L$)	0.81	0.81	1.03	1.16	1.83	3.26
Direct bilirubin (umol/L)	6.10	7.80	13.40	5.00	4.90	2.20
Alanine aminotransferase (U/L)	99.00	183.00	112.00	85.00	80.00	72.00
Alkaline phosphatase (U/L)	68.00	165.00	149.00	144.00	165.00	115.00
Γ -glutamyltranspeptidase (U/L)	351.00	404.00	311.00	192.00	249.00	152.00
α -Hydroxybutyrate Dehydrogenase (U/L)	283.00	278.00	228	177.00	149.00	244.00
Actic dehydrogenase (U/L)	406.00	368.00	261.00	229.00	207.00	286.00
C-Reactive Protein (mg/L)	67.04	36.94	30.85	42.76	56.49	3.85
PCT (ng/ml)	0.02	<0.02	<0.02	0.02	<0.02	<0.02
D-Dimer (mg/L)	0.16	1.10	1.70	1.73	2.71	2.17
Arterial PH	7.43	7.43	7.45	7.46	7.44	7.44
Pao ₂ (mmHg)	57.00	84.00	73.00	75.00	84.00	110.00
Oxygenation index	139.00	105.00	91.00	114.00	140.00	314.00

Conclusion

Nucleic acid testing should be carried out to identify the COVID-2019 in patients with a clear history of interaction with the epidemic area, acute onset of severe systemic symptoms unmatched with laboratory results, acute respiratory failure suggested by rapid chest CT imaging, and arterial blood gas analysis, as well as to exclude the possibility of other pneumonias. Early definitive diagnosis and comprehensive treatment of COVID-2019 can lessen complications and mortality.

Conflicts of Interest

All authors concur with the submission and have no conflicts of

interest related to this work.

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