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Research article

Clinical imaging research of the first Middle East respiratory syndrome in China

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Abstract

Middle East respiratory syndrome is a viral respiratory illness caused by a novel human beta-coronavirus. Based on the first case of Middle East respiratory syndrome found in China, a clinical research in combination with radiological findings was studied. Fever was the main clinical manifestation of this patient, and the primary imaging findings were basically the same as viral pneumonia. Differential imaging diagnosis on the basis of epidemiological and experimental pathogen detection is helpful for clinical diagnosis of MERS, even in distinguishing from SARS and pneumonia caused by H7N9 avian influenza.

Keywords: Middle East respiratory syndrome; Imaging; Infection

1. Introduction

Middle East respiratory syndrome (MERS), also known as camel flu, is a viral respiratory illness caused by a novel human beta-coronavirus (CoV) [1−3]. Since it was firstly reported by Saudi Arabia in September 2012, till June 2015, more than 1200 patients have been detected worldwide, with at least 427 cases of patients died [4,5]. Until June 2015, most of the cases of MERS-CoV infectors occurred in the Middle East, and recently, it is reported that South Korea has been sufferring from MERS. Symptoms may range from mild to severe, including fever, cough, diarrhea, and shortness of breath. Although the exact route of transmission is still unclear, the respiratory droplet route is currently most likely [6]. Although a few cases were reported in other countries, one was found in China in May 2015. A clinical research in combination with radiological findings was studied.

2. Materials and methods

2.1. Case history

A male Korean patient, born in 1971, had a close contact with his father who was diagnosed as the Middle East respiratory syndrome. He began to appear back pain on May 21, 2015, without fever, cough and sputum. No special treatment was given. He had a fever on May 25, 2015, with body temperature up to 39.7 °C, no chills, no cough, sputum, no shortness of breath, no abdominal pain, no diarrhea, and no sore throat. Cold medications were ineffective. On June 26 of 2015, he arrived in Hong Kong from South Korea by flight at 12:50, and then arrived in Huizhou City from Shenzhen. At 2:00 pm, May 28 of 2015, isolation and treatment was given for him in Huizhou designated hospital. During his whole

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journey in China, there were about 75 close contactors, who were all confirmed to be healthy after the isolated ward.

2.2. Physical examination

Body temperature was 39.0 °C, blood pressure was 126/78 mm Hg, heart rate was 98 beats/min, and breathing was 21 times/min. Breath sounds were ruder for the two lungs without coarse rales, heart rate was regular, abdomen was soft, and bowel sounded normal.

2.3. Laboratory tests after hospitalization

The blood gas analysis, Biochemistry, and Blood routine examination after hospitalization were shown in Table 1 and Table 2. Pathogenic examination (sputum virological detection) showed that MERS-COV was positive on June 1 of 2015, and the result changed to negative the second day.

2.4. Imaging examination and diagnosis

Mobile DR was implemented by employing the chest semi-recumbent on May 28 of 2015 after hospitalization, followed by May 30th, June 1st, June 3rd, June 4th, June 6th and June 8th. Obviously, pneumonia of the lower lungs was the primary finding (Fig. 1).

3. Results

Patients was in fever after May 28, 2015 hospitalized, lasting about a week between 38.0 °C and 39.5 °C (Fig. 2). Then with Tamiflu and ribavirin antiviral therapy, broad-spectrum antibiotic anti-infective therapy, oxygen therapy and improve immune function with gamma globulin, the virus was negative on June 2. Low white blood cell count had been gradually increased to normal in two days after the virus was negative (Fig. 3). According to 'cases of diagnosis and treatment of Middle East Respiratory Syndrome (2015 edition)' by the National Health Development Planning Commission, he was discharged on June 26, 2015.

4. Discussion and conclusion

It is well-known that incubation period of MERS is 2–14 days. Clinically, acute respiratory infection is the primary performance of MERS, accompanying with high fever (even reach to 39–40 °C), and sometimes with chills, shiver, cough, chest pain, headache, muscle and joint aches, fatigue, loss of appetite and so on. On the basis of pneumonia, the MERS rapidly developed into respiratory failure, acute respiratory distress syndrome (ARDS) or acute renal failure. Diarrhea and other atypical clinical manifestations might occur to individual cases (such as immunodeficiency cases). In this study, the patient suffered from fever (up to 39.5 °C) and back pain firstly. After hospitalization for one week, his body temperature returned to normal (Fig. 2), but still being in cough with a small amount of yellow phlegm and a little bloodshot; and there is no shortness of breath at rest and oxygen therapy. On the sixth day after his hospitalization, MERS-COV was negative via the virological detection of sputum, and his body temperature had decreased to be normal, which indicated that the virus has a direct relationship with the fever. Laboratory tests found that the leukocytes count in the peripheral blood had decreased obviously since his hospitalization, and the count was about 3.00×10^9/L lasting for nine days, followed by increasing and till the 27th days it recovered to the normal level. This indicated that MERS-CoV mainly attacked human immune system, resulting in a significant reduce of leukocytes count; after the virus was cleared, the recovery may be a relatively slow process due to the leukocytes count recovered to the normal range for about two weeks after the virus return to be negative.

The camel and bat are always thought to be the main infection source, but the animal to human infection process was not so clear till now. Generally, human to human infection should be paid more attention, for MERS-CoV would spread

Table 2
The biochemistry, and blood routine examination after hospitalization.

Biochemistry		Blood routine examination	
ALT	24 U/L	WRC	3.22×10^9/L
AST	57U/L	NE	2.35
AST/ALT	2.38	PLT	81×10^9/L
CK-MB	8 U/L	RBC	4.7×10^{12}/L
GLU	5.7 mmol/L	/	/
Urea	5.4 mmol/L	/	/
UA	308umol/L	/	/
Cr	54umol/L	/	/

Table 1
The blood gas analysis after hospitalization.

Items	Results	Items	Results
Lactic acid	1.8 mmol/L	Bicarbonate	21.4 mmol/L
PH	7.41	Extracellular base excess	−2.5 mmol/L
Partial pressure of carbon dioxide	34.4 mm Hg	Alveolar blood oxygen partial pressure	171 mm Hg
Oxygen partial pressure	72 mm Hg	BB	−2.2 mmol/L
Hematocrit	44%	Difference of alveolar-arterial oxygen pressure	99 mm Hg
Base excess	−2.0 mmol/L	a/AO2	41.9
SO_2 (c)	94.5%	K^+	4.21 mmol/L
Cl^-	97 mmol/L	Na^+	132 mmol/L

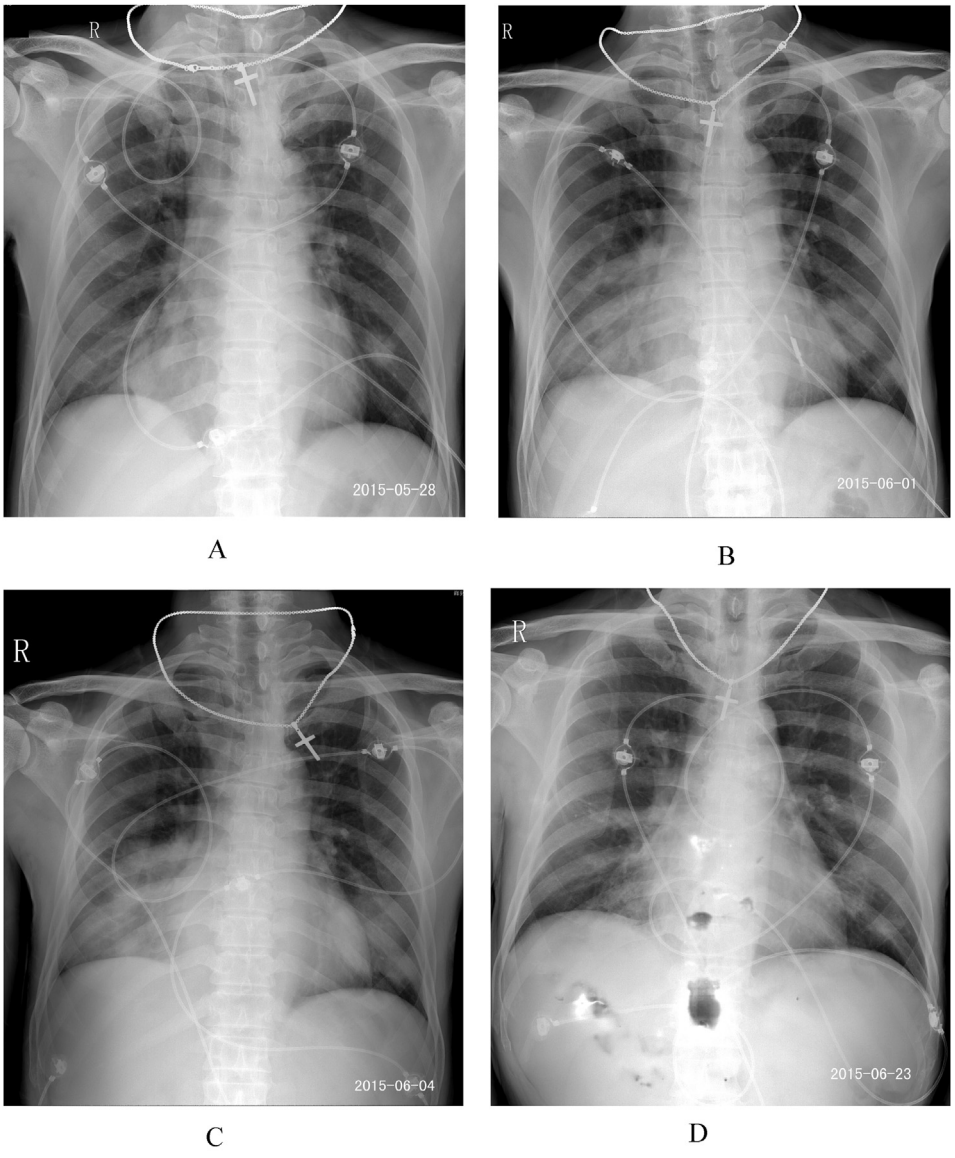

Fig. 1. Chest radiograph of a 44-year male patient with the Middle East respiratory syndrome. **A**. On the 7th day after hospitalization, the chest radiograph revealed the little patchy increased density shadow in the two lower lungs near the edge of heart. **B**. On the 10th day after hospitalization, the chest radiograph revealed two obviously increased patchy shadows in the two lower lungs, the degree of lower right lung was more serious. **C**. On the 13th day, the patchy lesions progressed to be large patchy consolidation shadows. **D**. On the 32nd day, chest radiograph showed two obvious absorptions in the lower lung lesions, only small pieces of the grid shadow could be observed.

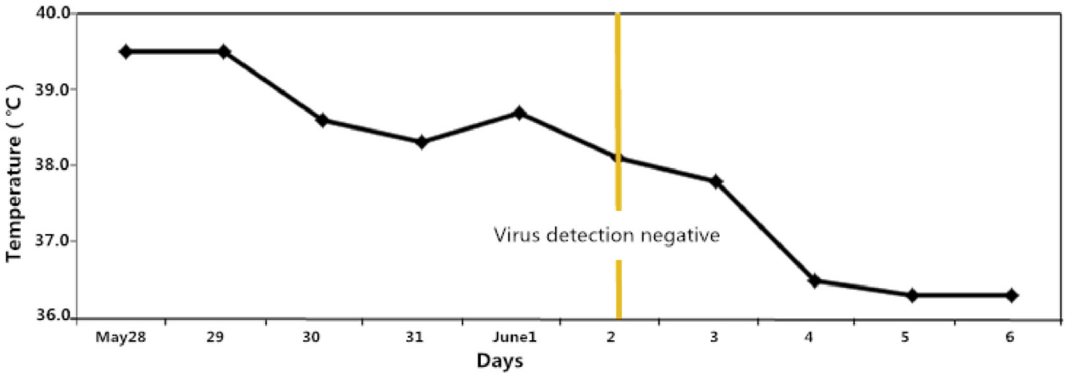

Fig. 2. The relationship of temperature changes and viral negative.

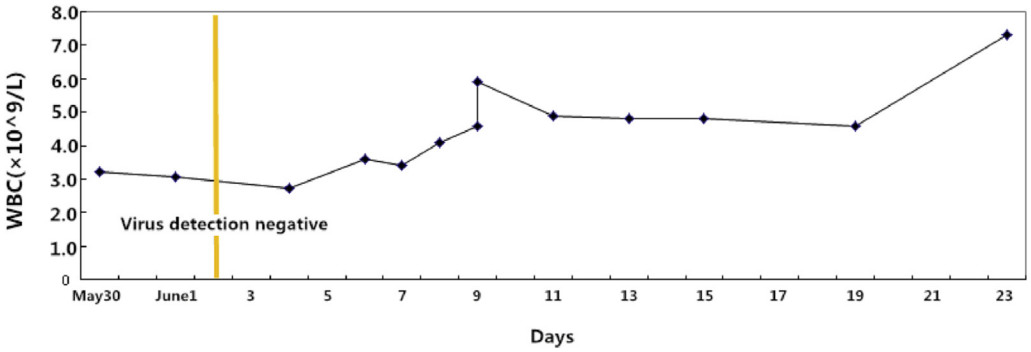

Fig. 3. Relationship of peripheral blood leukocyte counts and viral negative.

by direct contact of patients' secretions, or by aerosol and droplets. As is reported, there is an evidence of limited person-to-person transmission of MERS [7,8]. In this study, 75 people who had more or less contact with the patient were without any further infection. This limited transmissibility is consistent with the data available to date [8].

Radiological manifestations of MERS are lungs consolidation and ground glass, due to the fact that the MERS-CoV primary lead to viral pneumonia [3]. Imaging findings in this case were characteristic by the following three stages. 1) Small pieces of high density shadows in the two lower lungs near the heart edge were observed during the early period via chest X-ray examination, suggesting that it firstly progressed to pneumonia (about one week). 2) Subsequently, the lesions gradually expanded. Further chest X-ray examination showed large pieces of high density shadows in the middle right lower lung, oval pieces of high density shadows in the left lower lung field, and clear boundaries of the two upper lungs. 3) After the active antiretroviral therapy, the virus turned to be negative, the body temperature decreased to normal level (Fig. 2), and leukocyte count also began to rise (Fig. 3). Chest X-ray of deferred examination showed the gradually foci absorbed in both lungs, being consistence with clinical changes.

Differential diagnosis of pneumonia imaging result from MERS, SARS or H7N9 avian influenza is necessary. Due to the fact that both SARS and MERS belong to the coronavirus family, their nucleotide homologies for one same PCR fragment are 70%−80%, their radiographic manifestations have in common. Both showed ground glass shadows and pulmonary opacities in the middle and lower lung lobes, accompanying with a rapid disease progression. Via High-resolution CT scans, septal thickening and bronchiectasis could be both observed. However, ground glass opacities and consolidation of SARS were relatively mild, with the lesions of a migratory change [9−11]. As for MERS and H7N9 avian influenza, their common characteristics were ground glass shadows and pulmonary opacities in both lower lung lobes, except for that disease progression of H7N9 avian influenza infection might be more rapid [10,11]. Summarily, differential imaging diagnosis on the basis of epidemiological and experimental pathogen detection is helpful for clinical diagnosis of MERS, even in distinguishing from SARS or pneumonia caused by H7N9 avian influenza.

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