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ORIGINAL ARTICLE

MERS-CoV: Middle East respiratory syndrome corona virus: Can radiology be of help? Initial single center experience

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KEYWORDS

MERS-CoV;
CT;
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Abstract Human infection with a novel coronavirus named Middle East respiratory syndrome coronavirus (MERS-CoV) was first identified in Saudi Arabia and the Middle East in September, 2012. The aim of this study was to establish the most pathognomonic radiological sign(s) to diagnose MERS CoV.

Patients and methods: This is a retrospective descriptive study. All patients were subjected to serial X-ray. High resolution non-contrast CT chest was also obtained for 10 patients. The scans were reviewed for findings including consolidation, ground-glass opacities, nodules, reticular opacities and hilar and mediastinal adenopathy.

Results: A total of 12 patients were included in our study with prevalence of males (2:1) with ages ranging between 18 and 76 years having an average age of 36 ± 2 years. The outcome of these patients was as follows: 6 were treated with average hospital stay ranging between 21 and 35 days, one case died after 14 days, and 5 cases were transferred to Central Governmental hospital according the local authority rules.

Conclusions: MERS CoV virus may have a specific pattern in chest X-ray and CT developing a single or multiple opacities progressing into a widespread multifocal bilateral patches of ground glass opacities or confluent consolidation resembling organizing pneumonia.

1. Introduction

Human infection with a novel coronavirus named Middle East respiratory syndrome coronavirus (MERS-CoV) was first identified in Saudi Arabia and the Middle East in September, 2012, with 44 laboratory-confirmed cases as of May 23, 2013. Since April 2012, 536 laboratory-confirmed cases of human infection with Middle East respiratory syndrome coronavirus

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(MERS-CoV) have been reported to WHO, including 145 deaths. The reports of its person-to-person transmission through close contacts have raised a global concern about its pandemic potential. Near two-thirds of the cases were in Saudi Arabia (1).

Case definitions into probable, suspected and confirmed cases were put into action. They are mainly relying on Lab test Criteria to establish the diagnosis (2).

The description of the radiologic manifestations of viral pneumonia has been limited to a few case reports and carries a wide variety findings that are not consistent or pathognomonic for certain disease entity (3–6).

The aim of this study was to try to look for the most pathognomonic radiological sign(s) enabling radiologist to offer some help in the diagnosis of MERS CoV.

2. Patients and methods

This is a retrospective descriptive study. No informed consent was necessary as the study being retrospective.

Institutional hospital information system (HIS) and radiology picture archiving computer system (PACS) were reviewed for patients confirmed positive for corona virus by serological test (real-time reverse transcriptase polymerase chain reaction (RT-PCR) of nasal/nasopharyngeal swabs or aspirates according to Case Definition and Surveillance Guidance for MERS-CoV Testing in Saudi Arabia – 13 May 2014.

Laboratory workup includes complete blood picture, erythrocyte sedimentation rate (ESR) and C-reactive protein.

A total of 12 patients were included in our study.

Laboratory tests include complete blood picture, C-reactive protein, ESR and virus profile.

All patients were subjected to serial X-ray – one view frontal radiograms. Upon presentation; 8 cases were able to be imaged in postero-anterior view while the rest were done in AP view whether in supine or setting position. Follow-up X-ray was obtained on daily bases. X-ray was done on Siemens Multix vertex (Germany): PA: averaging kV 125 and mAs 3.2 and AP: kV 70–77 and mAs 4–6.3) Siemens or Axiom Aristos (Germany): Kv125 and mAs: 1.99.

High resolution non-contrast CT chest was also obtained for 10 patients. The machine is Toshiba Aquilion Vision 320 CT scanner – Japan: CT is usually obtained 1–2 days after admission. Follow-up CT was done in all of the 6 treated patients usually once 2–3 days after initial CT. In two cases follow-up high resolution CT was done for three times.

CT technique: No preparation needed.
Patient position: Supine, foot first.
Scanogram: Two scanograms were taken AP and lateral, kV: 120 – mA: 50 – range 500.
Scan: Helical scan.
Standard pitch, kV: 120, mAs: 150–200, tube rotation time: 0.275 s, total scan time: 3.5–4 s. Radiation dose delivered to the patient ranged between 2.3 and 5.2 mSv with an average of 3.2 ± 0.3 mSv.

Reconstruction was done into Axial 1 mm thick standard lung settings and axial, coronal and sagittal 5 mm thick soft tissue settings.

Images were sent to the PACS (Agfa healthcare system).

The scans were reviewed for findings including consolidation, ground-glass opacities, nodules, reticular opacities and hilar and mediastinal adenopathy. The findings were categorized into focal or diffuse and unilateral or bilateral. Predominant distribution was also assessed as being in the upper, middle, or lower lung zone and as being in a random, predominantly central or peribronchovascular, or subpleural location.

These lesions were defined as follows: Consolidation was defined as ill-defined homogeneous opacity obscuring vessels.

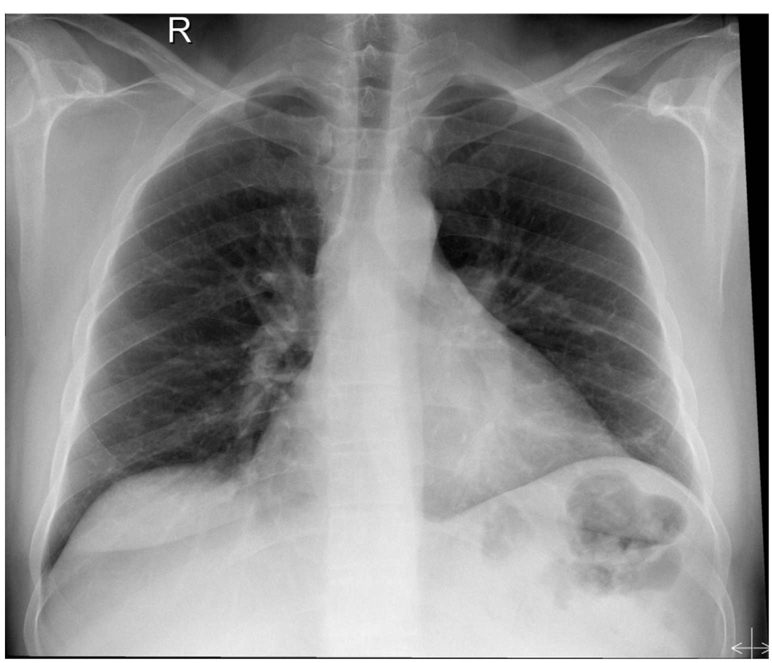

Fig. 1a A case of MERS-CoV; Chest X-ray; frontal projection at day of presentation showing small left paracardiac possible infiltrate.

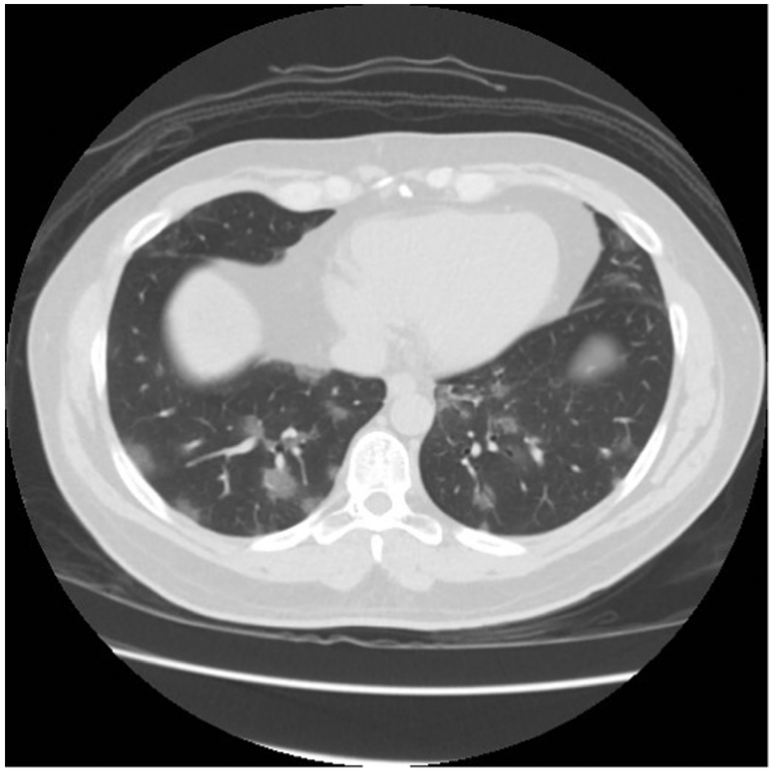

Fig. 1b A case of MERS-CoV; Axial CT image in pulmonary window second day after presentation showing bilateral ill defined ground glass opacities.

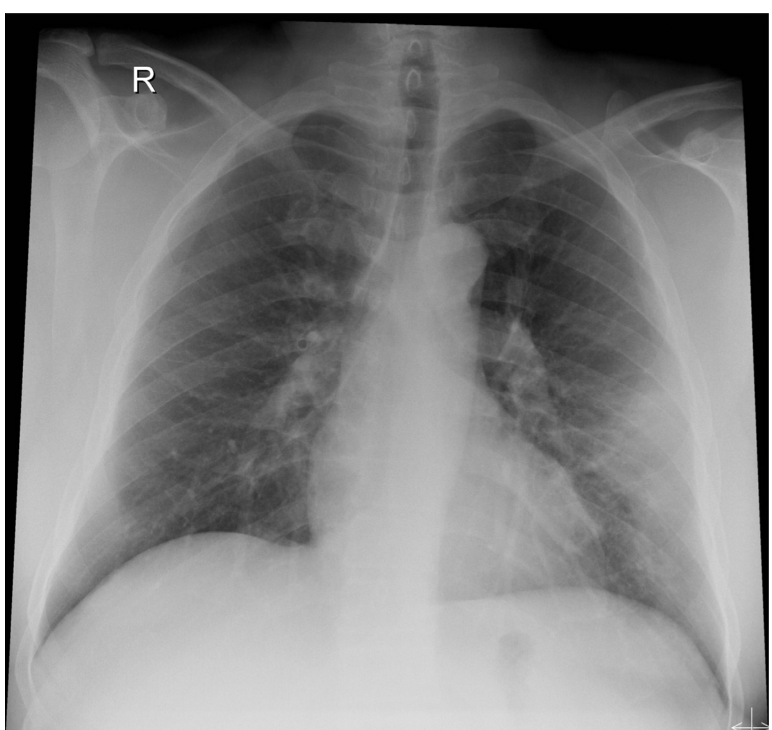

Fig. 2a A case of MERS-CoV; Chest X-ray; frontal projection at day of presentation showing left lower zonal pleural based peripheral opacity.

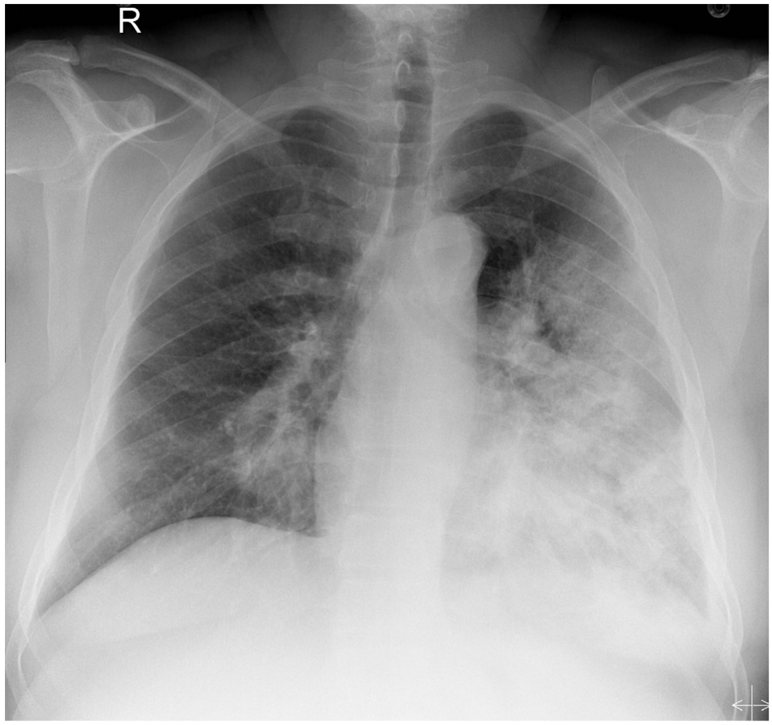

Fig. 2b A case of MERS-CoV; Chest X-ray; frontal projection three days after admission showing progression of left lung opacity with extension into the left mid-zone and subtle right paracardiac opacity.

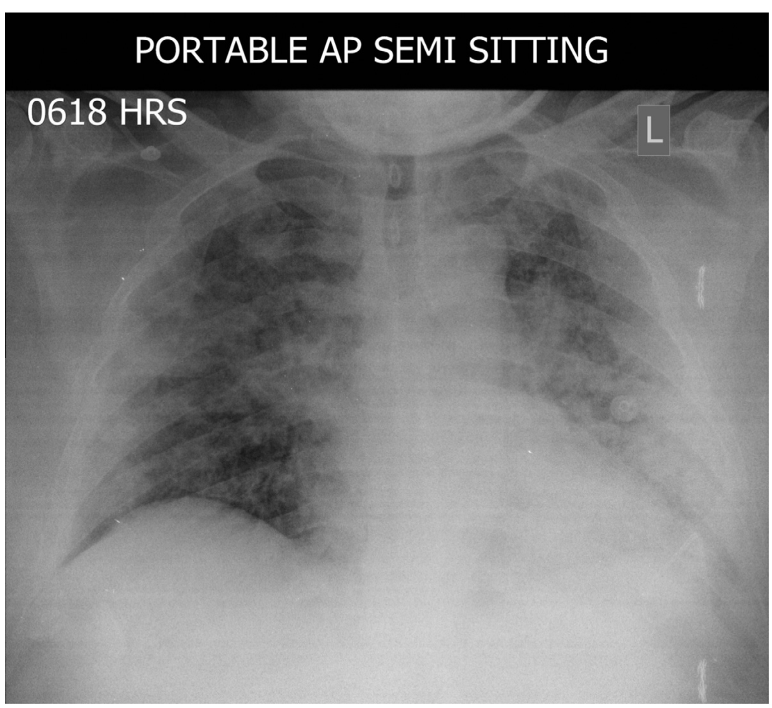

Fig. 2c A case of MERS-CoV; Chest X-ray; frontal projection 11 days after admission showing progression with bilateral multifocal opacities.

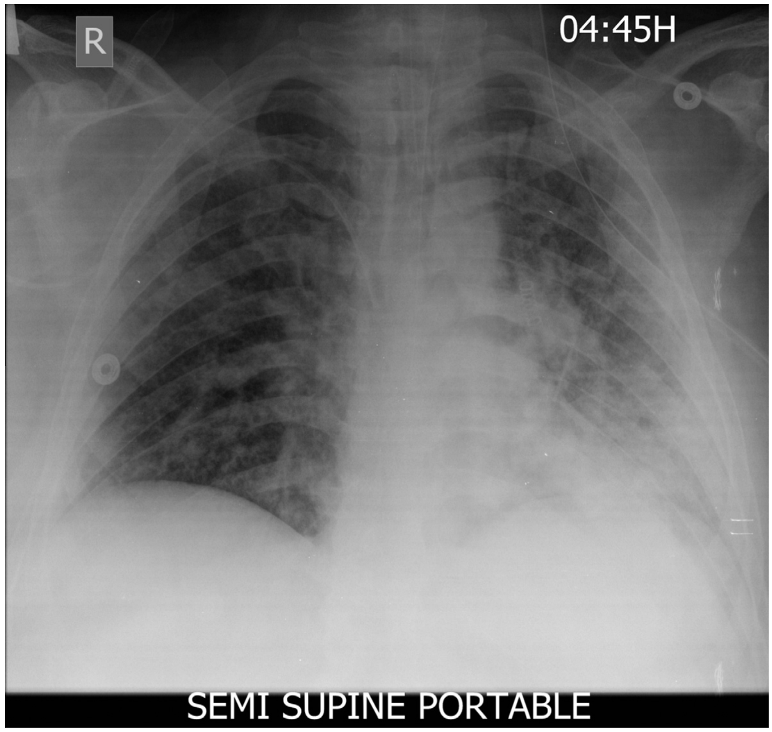

Fig. 2d A case of MERS-CoV; Chest X-ray; frontal projection 18 days after admission showing partial regression of bilateral multifocal pulmonary opacities.

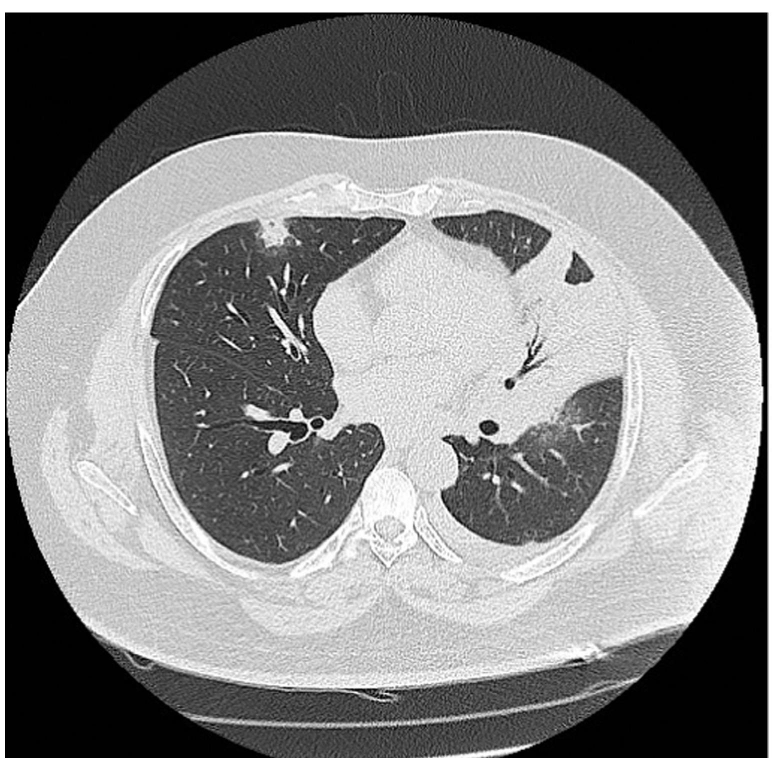

Fig. 2e A case of MERS-CoV; Axial CT in pulmonary window 2 days after admission showing left pulmonary consolidation with smaller one (not seen in X-ray) within the right middle lobe.

Fig. 2f A case of MERS-CoV; Axial CT in pulmonary window 10 days after admission showing progression of left pulmonary consolidation with multiple smaller infiltrates; partly ground glass within the right lung.

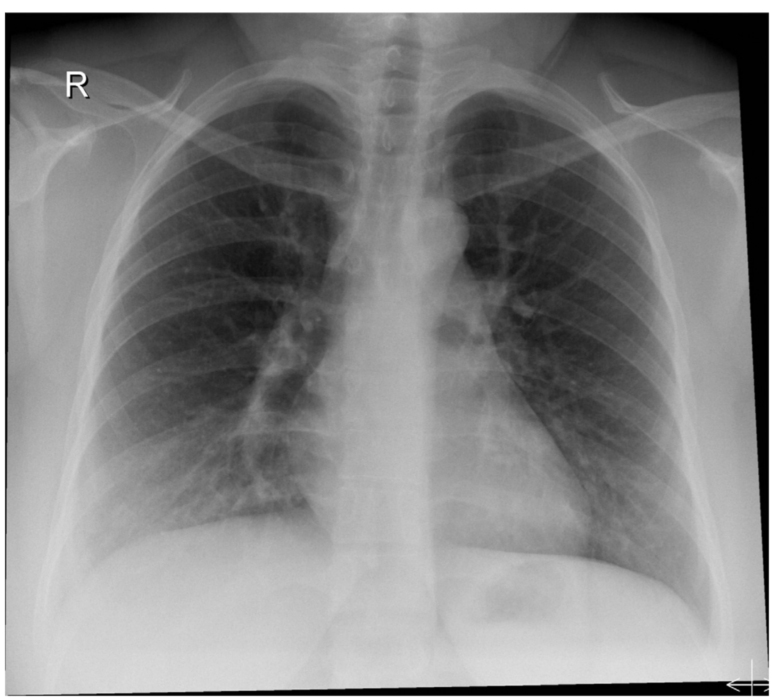

Fig. 3a Chest X-ray frontal projection in the day of admission showing faint opacity within the right paracardiac region.

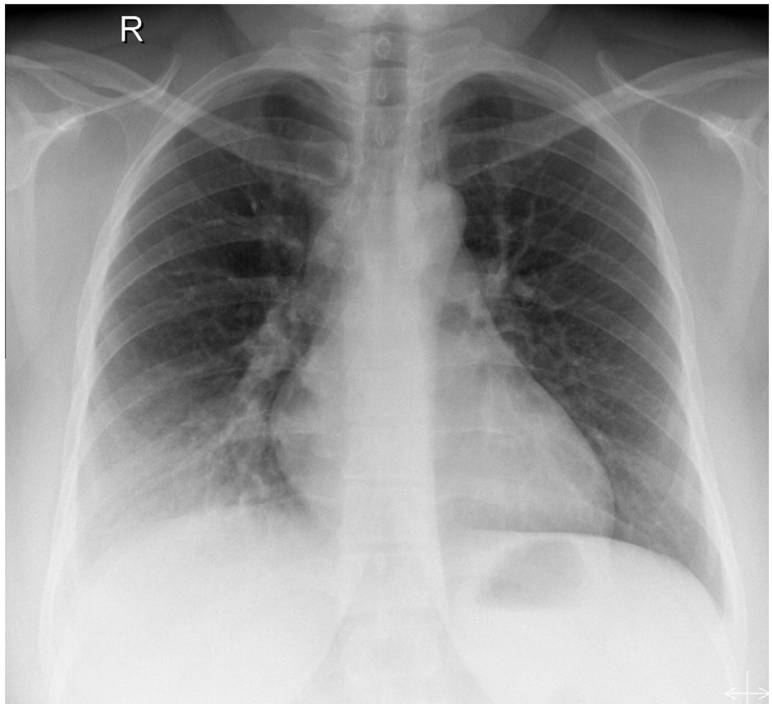

Fig. 3b Chest X-ray frontal projection second day after admission showing progression of the right lower zonal opacity.

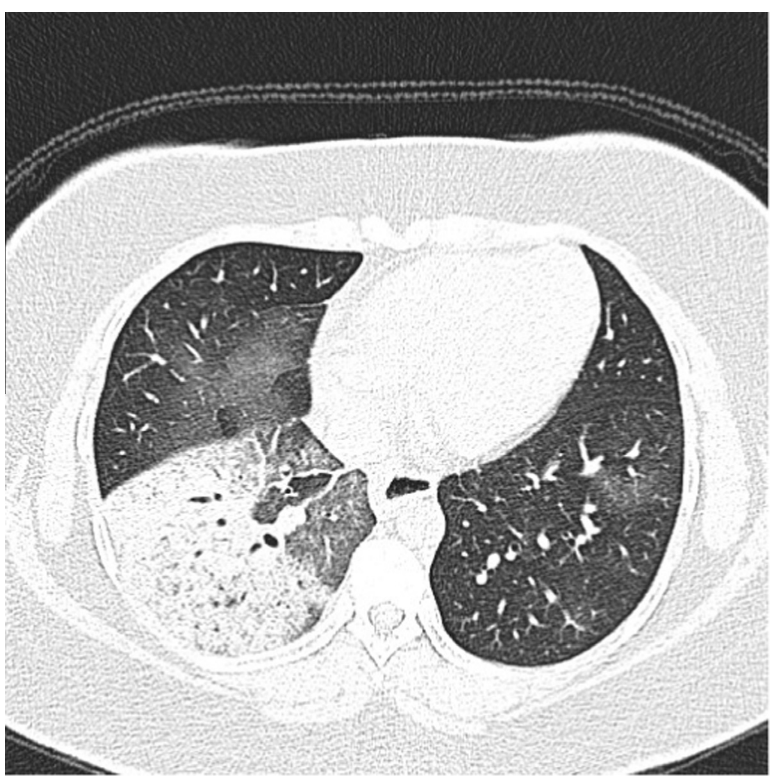

Fig. 3c Axial CT scan in lung window setting showing dense consolidation within the right lower lobe with bilateral patches of ground glass opacities.

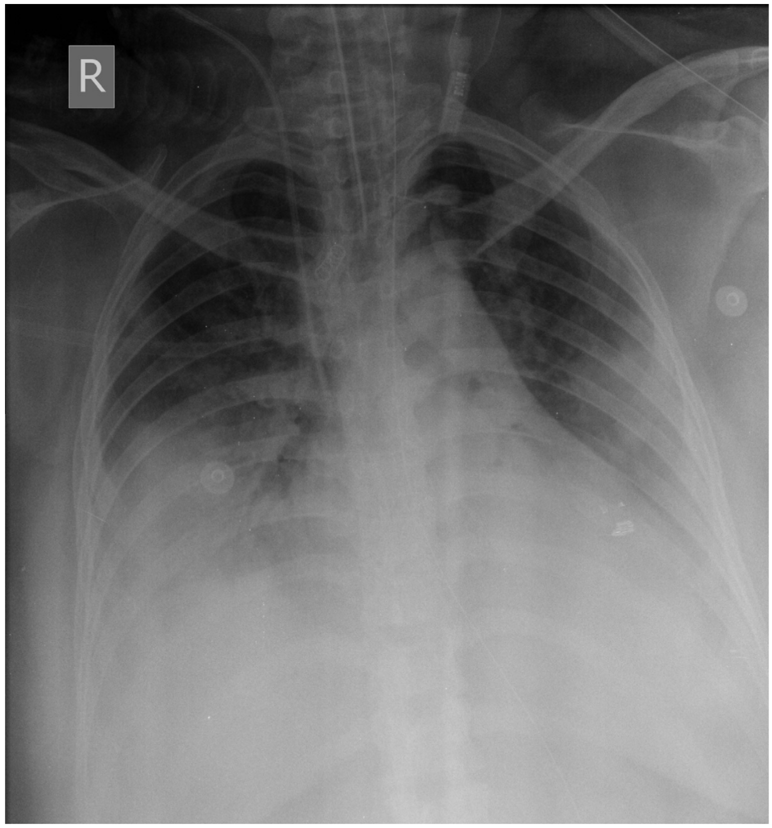

Fig. 3d Chest X-ray frontal projection 8 days after admission showing bilateral patches of consolidation mainly within the mid and lower zones. Nasogastric and endotracheal tubes as well as right central venous line are noted.

Fig. 4a Chest X-ray frontal projection at day of presentation.

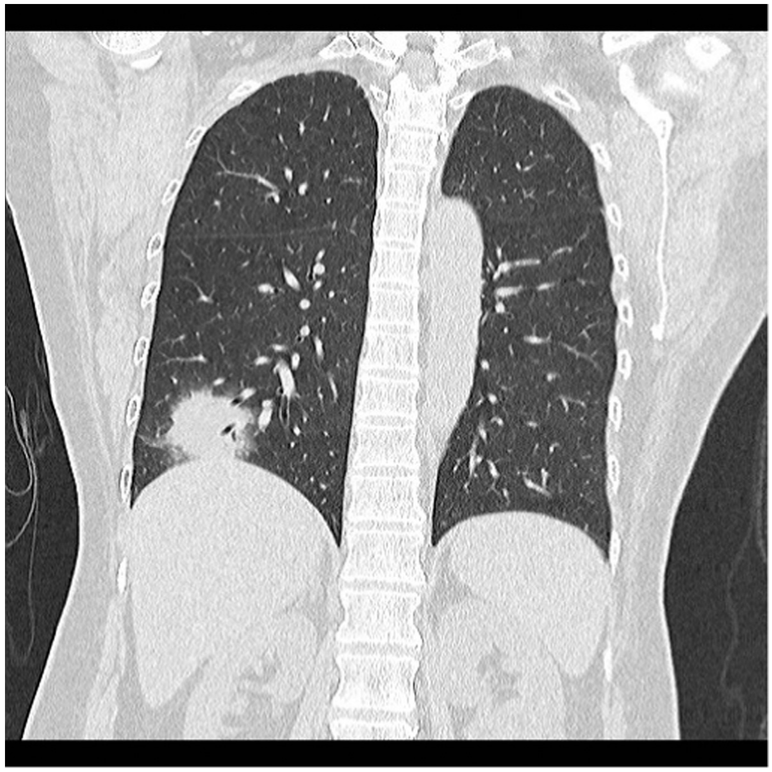

Fig. 4b Coronal CT of the chest in pulmonary window at presentation showing the opacity much distinct in the right lower lobe.

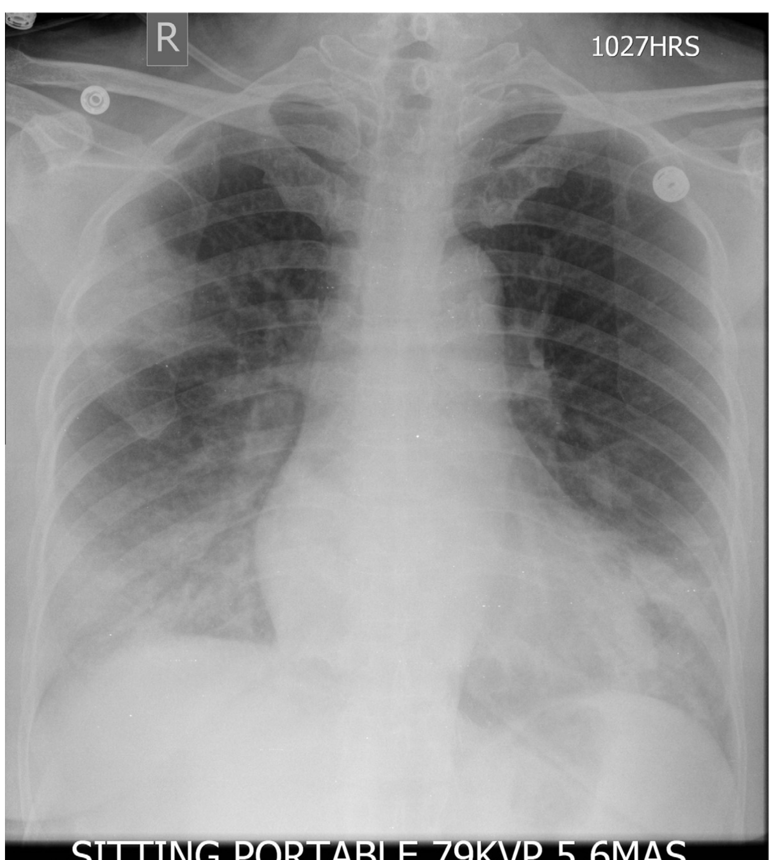

Fig. 4c Chest X-ray frontal projection 3 days after presentation showing progression with multifocal peripheral pulmonary opacities.

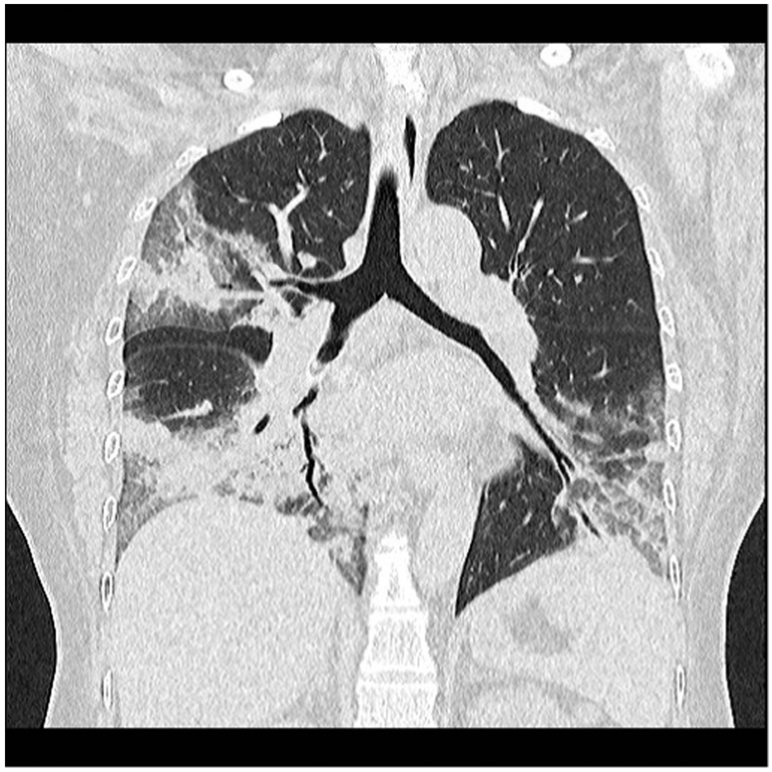

Fig. 4d Coronal CT of the chest in pulmonary window 8 days after presentation showing multifocal patches of consolidation denser in lower lobes with air bronchogram.

Nodular opacities are those with foci with rounded contour. Reticular opacities were defined as linear opacities forming a meshlike pattern (7).

3. Results

A total of 12 patients were included in our study with prevalence of males (2:1) with ages ranging between 18 and 76 years having an average age of 36 ± 2 years. Patients were presented to our emergency department. All were complaining of variable degrees of fever ranging between 38.2 and 41.5 °C with an average of 39.4° ± 0.3°. Chest pain was not a prominent feature; occurring in only 6 cases. Variable degrees of cough and dyspnea occur in 10 cases. Co-morbidities include diabetes mellitus (n = 3), hypertension (n = 2), coronary artery disease (n = 1) and asthma (n = 1).

Laboratory tests upon presentation showed lymphocytosis in 9 cases, monocytosis in 9 cases, anemia (usually mild) in 6 cases, high C-reactive protein and ESR in almost all cases (11/12).

Virus profile was done for influenza plus B, and H1N1 viruses were done. Laboratory tests for corona virus; namely real-time reverse transcriptase polymerase chain reaction (RT-PCR) of nasal/nasopharyngeal swabs or aspirates were done for all patients. The specimen was collected in the hospital and transferred to the Central Governmental laboratories. The results were convoyed back to the hospital. The test proved positive in all cases; however, it was proved positive in the first time in 6 cases, negative at first and positive in repeat test in 4 cases and only positive in third trial in 2 cases. Combined H1N1-MERS-CoV infections were detected in only one patient.

The outcome of these patients was as follows: 6 were treated with average hospital stay ranging between 21 and 35 days, one case died after 14 days, and 5 cases were transferred to Central Governmental hospital according the local authority rules. They were transferred after positive test results for MERS-CoV had been obtained. Their period of stays averages 8 days (range of 2–15 days).

3.1. Radiology

Among the 12 patients; 5 cases showed completely normal initial X-ray on presentation. Five of our patients showed one or more scattered patches of rather confluent airspace fillings within one or both lungs. The other two showed rather large consolidations.

All patients regarding their presentation will develop the appearance of multiple variable sized peripherally located or pleural based opacities scattered within both lungs at upper and lower zones; although lower zones predilection is commoner; 11 of them develop dense consolidation with two showing small cavity formation and one case showed ground glass densities. Associated more or less diffuse ground glass opacities as well as subpleural reticular pattern were noted either initially before developing the full prone picture of infection of multifocal opacities in 8 cases or occurring late in disease during resolution.

Nodules; were not a feature of the disease. One case showed small 3 mm nodule that was present in previous CT (15 months before) and considered as incidental findings.

Associated pleural effusions are usually mild to moderate and paralleling the extent of parenchymal disease occurring

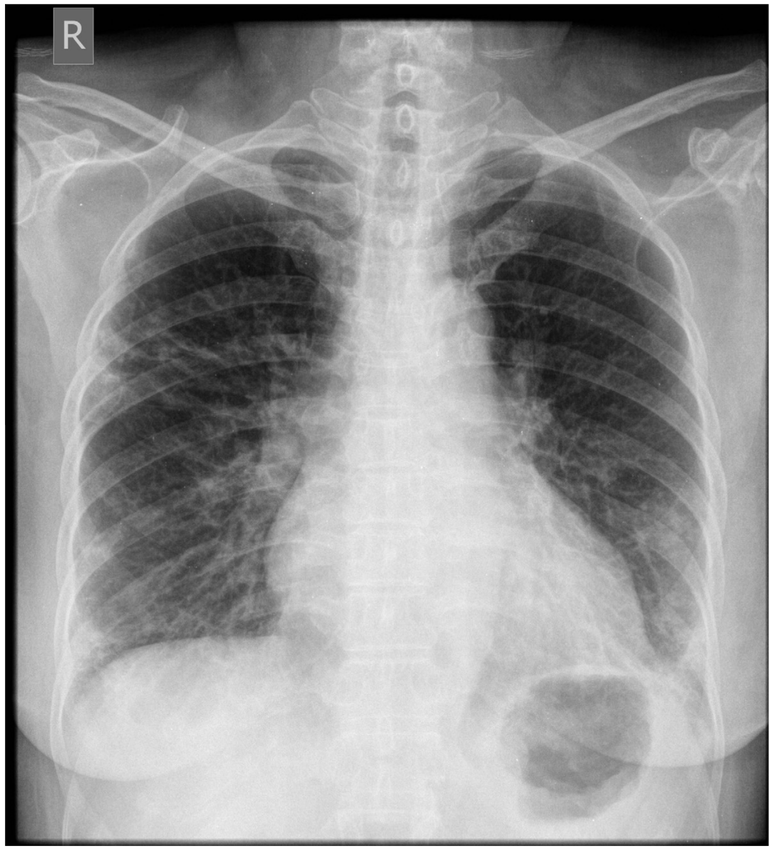

Fig. 4e Chest X-ray frontal projection after two months showing multiple bilateral fibrotic bands.

in 8 cases. The need for drainage as a therapeutic measure was needed in only 4 cases.

Mediastinal nodes were detected in all cases performing CT but they were discrete; relatively small with no abnormal enhancement, calcifications or necrosis.

No significant relevant osseous or extra-thoracic findings were detected in CT chest.

4. Discussion

Middle East respiratory syndrome (MERS) is viral respiratory illness first reported in Saudi Arabia in 2012. It is caused by a coronavirus called MERS-CoV. Most people who have been confirmed to have MERS-CoV infection developed severe acute respiratory illness. They had fever, cough, and shortness of breath. About 30% of people confirmed to have MERS-CoV infection have died (8).

The Middle East respiratory syndrome coronavirus (MERS-CoV), also termed EMC/2012 (HCoV-EMC/2012), is positive-sense, single-stranded RNA novel species of the genus Betacoronavirus (9).

Over the past year, several investigations into the animal source of MERS-CoV have been conducted. MERS-CoV genetic sequences from humans and camels in Egypt, Oman, Qatar and Saudi Arabia demonstrate a close link between the virus found in camels and that found in people in the same geographic area. These and other studies have found MERS-CoV antibodies in camels in Africa and the Middle East (10).

Since April 2012, 536 laboratory-confirmed cases of human infection with Middle East respiratory syndrome coronavirus (MERS-CoV) have been reported to WHO, including 145 deaths (Fig. 1). To date, the affected countries in the Middle East include Jordan, Kuwait, Oman, Qatar, Saudi Arabia (KSA), United Arab Emirates (UAE) and Yemen; in Africa: Egypt and Tunisia; in Europe: France, Germany, Greece, Italy and the United Kingdom; in Asia: Malaysia and Philippines; and in North America: the United States of America (USA). All of the cases recently reported outside the Middle East (Egypt, Greece, Malaysia, the Philippines and the USA) recently traveled from countries inside of the Middle East (KSA or UAE). Overall, 65.6% of cases are male and the median age is 49 years (range 9 months–94 years old) (3) (see Figs. 2a–2f).

Studies describing the radiological findings of recent viral attacks such as SARS, H1N1 and MERS-CoV are little and many failed to detect specific pattern. Owing to the acuteness, high rate of transmission and rather small number of cases; this can be explained (see Figs. 3a–3d).

Ajlan described a rather specific pattern for H1N1 infection concluding that; the most common radiographic and MDCT findings in patients with S-OIV infection are unilateral or bilateral ground-glass opacities with or without associated focal or multifocal areas of consolidation. On MDCT, the ground-glass opacities and areas of consolidation had a predominant peribronchovascular and subpleural distribution that resembled the appearance of organizing pneumonia (11).

In 2014 Ajlan et al. also suggested that; the most common CT finding in hospitalized patients with MERS-CoV infection is that of bilateral predominantly subpleural and basilar airspace changes (12).

The bilateral pulmonary lesions may heal with fibrosis as evidenced in one case; but yet this finding may need further follow-up (see Figs. 4a–4e).

Our results agree with Ajlan et al. that if the disease is to progress and becoming symptomatic, we should expect bilateral multifocal mainly peripheral ground glass opacities or confluent consolidations resembling organizing pneumonia pattern.

The problem with MERS CoV is that negative laboratory tests do not exclude the disease and should be repeated and the exact incubation period is uncertain. The course of the disease is not predictable. Enormous efforts by the relevant authorities succeeded in overcoming the outbreak with only few cases were recorded recently (13).

In my experience if a patient present with fever and lymphocytosis, a chest X-ray might be very helpful in directing the attention to the MERS CoV infection in the appropriate settings. This was quite helpful in lowering threshold of our ER doctors for the diagnosis of such cases in ER settings.

A chest X-ray with single or multiple focal opacities with otherwise normal lung should be considered positive for specific infection till otherwise proved. A patient progressing rapidly despite treatment into multifocal opacities should perform CT and expected is to find a more aggressive involvement; a pattern of organizing pneumonia is very suggestive of MERS CoV.

The strengths of this study are that to our knowledge, only few papers have been published for the description of radiological data about MERS CoV. Only a couple actually found a specific pattern. Most of papers published on MERS-CoV and many on H1N1 stated non-specific pattern. Despite the limited number of patients, yet the 12 cases listed are actually 5% of all cases recorded in history. Actually some multicenter studies did not exceed 15 cases in number (11,14).

Another thing the radiological signs were mounted against solid investigative results.

The weaknesses however are that still it is a single center study and there is considerable cross-over with findings in another specific viral infection which is H1N1 and both might co-exist in the same patient. However; we should know that H1N1 and MERS CoV are actually adenoviruses and cross-over of their clinical and radiological picture may not be surprising. Many authors pointed to the similarities between both entities (15,16).

5. Conclusions

MERS CoV virus may have a specific pattern in chest X-ray and CT developing a single or multiple opacities progressing into a widespread multifocal bilateral patches of ground glass opacities or confluent consolidation resembling organizing pneumonia. This might resemble similar viruses such as H1N1 but this helps to pick cases for quarantine and appropriate management prior to the appearance of virus specific laboratory tests.

Conflict of interest

None declared.

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