

Original Article**Thoracic computerized tomographic (CT) findings in 2009 influenza A (H1N1) virus infection in Isfahan, Iran**

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**Abstract**

**BACKGROUND:** Pandemic 2009 H1N1 influenza A virus arrived at Isfahan in August 2009. The virus is still circulating in the world. The abnormal thoracic computerized tomographic (CT) scan findings vary widely among the studies of 2009 H1N1 influenza. We evaluated the thoracic CT findings in patients with 2009 H1N1 virus infection to describe findings compared to previously reported findings, and to suggest patterns that may be suggestive for 2009 influenza A (H1N1) in an appropriate clinical setting.

**METHODS:** Retrospectively, the archive of all patients with a diagnosis of 2009 H1N1 influenza A were reviewed, in Al-Zahra Hospital in Isfahan, central Iran, between September 23<sup>rd</sup> 2009 to February 20<sup>th</sup> 2010. Out of 216 patients with confirmed 2009 influenza A (H1N1) virus, 26 cases with abnormal CT were enrolled in the study. Radiologic findings were characterized by the type and pattern of opacities and zonal distribution.

**RESULTS:** Patchy infiltration (34.6%), lobar consolidation (30.8%), and interstitial infiltration (26.9%) with airbronchogram (38.5%) were the predominant findings in our patients. Bilateral distribution was seen in 80.8% of the patients. Only one patient (3.8%) showed ground-glass opacity, predominant radiographic finding in the previous reports and severe acute respiratory syndrome (SARS).

**CONCLUSIONS:** The most common thoracic CT findings in pandemic H1N1 were patchy infiltration, lobar consolidation, and interstitial infiltration with airbronchogram and bilateral distribution. While these findings can be associated with other infections; they may be suggestive to 2009 influenza A (H1N1) in the appropriate clinical setting. Various radiographic patterns can be seen in thoracic CT scans of the influenza patients. Imaging findings are nonspecific.

**KEYWORDS:** Thorax, Computed Tomography (CT), Influenza A Virus, H1N1 Subtype.

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**N**ovel swine-origin influenza A (2009 H1N1) was first reported in Mexico in April 2009.<sup>1</sup> Since then, it has spread rapidly around the world. In June 2009, the World Health Organization (WHO) declared the emergence of a global pandemic, raising the alert level to phase 6 or pandemic phase.<sup>2</sup>

This virus arrived at Isfahan in August 2009. The 2009 H1N1 virus is a subtype of the influenza A virus. Unfortunately, the most virulent influenza viruses are type A, and they mutate easily and quickly.<sup>3,4</sup> The symptoms of H1N1 infection may be similar to seasonal influenza, and hospitalization is not usually required.

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This virus causes a broad spectrum of clinical syndromes, ranging from mild to severe, and can infect the lower respiratory tract as well as cause rapidly progressive pneumonia, especially in children and younger adults.<sup>5</sup> The virus is still circulating in the world.

The abnormal thoracic computerized tomography (CT) scan findings vary widely among the studies of 2009 H1N1 influenza. Differences in diagnostics, admission criteria and health care systems may all play roles in this regard.<sup>6-8</sup>

In this study, we retrospectively evaluated the thoracic CT findings in patients with confirmed 2009 H1N1 virus infection. There has been no study about the thoracic CT findings in 2009 H1N1 in Iran in the literature.

This study aimed to describe thoracic CT findings of the patients with confirmed pandemic 2009 influenza A (H1N1) infection compared to previously reported CT findings, and also to suggest patterns that may be suggestive of 2009 influenza A (H1N1) in the appropriate clinical setting.

## Methods

After arrival of the 2009 influenza A (H1N1) virus infection to Isfahan, the infectious diseases and Tropical Medicine Research Center of Isfahan University of Medical Sciences decided to evaluate the clinical features and radiologic findings of the disease. This article was the section of thoracic CT findings. Data were collected from all the consecutive patients admitted to the infectious diseases and tropical medicine department in Al-Zahra Hospital in Isfahan, central Iran, from September 23<sup>rd</sup> in 2009 to February 20<sup>th</sup> in 2010 who fulfilled the criteria for confirmation of H1N1 influenza infection, as established by the U.S. Centers for Disease Control and Prevention.<sup>3,9,10</sup> These criteria include flu-like symptoms such as a body temperature of 37.8°C (100°F) or higher, cough or sore throat, and a real-time reverse transcriptase polymerase chain reaction (RT-PCR) of nasal swabs or aspirates with positive results for 2009 H1N1 virus. The clinical diagnosis of suspected or probable cases had been

made by trained residents or attending physicians of the infectious diseases center. For confirmation, nasopharyngeal samples had been sent to the National Influenza Reference Laboratory at Tehran School of Public Health in a viral transport medium (virocult, Medical wire & Equipment, UK) and had been tested with the real time RT-PCR protocol and reagents supplied by the WHO. The patients did not have computerized medical records about confirmation of H1N1 influenza infection, and such data were collected from Public Health Department. Out of 216 patients with confirmed 2009 H1N1 virus infection, 111 patients had chest radiographs, and 40 patients had thoracic CT scan with intravenous (IV) contrast on admission time or during the hospitalization, depending upon the clinical judgment of the clinicians. Sixteen patients had normal thoracic CT. Twenty-six patients with abnormal thoracic CT findings were enrolled in the study. The findings which were compatible with acute infective process (primary viral, secondary bacterial or mixed pneumonia) were then described according to the pattern of the opacity. CT scans were assessed for the presence of ground-glass opacities, consolidation, airbronchogram, diffuse alveolar opacities, patchy infiltrations, interstitial infiltrations, and cavity and tree-in-bud pattern. The presence of pleural, subpleural, or peribronchial/central abnormalities as well as adenopathy was also

Data were analyzed using Software SPSS<sub>16</sub> (SPSS Inc., Chicago, Ill, USA).

## Results

This study included 26 patients with confirmed diagnosis of 2009 H1N1 influenza virus infection who had abnormal thoracic CT scans. Out of these 26 patients, 16 (61.5%) were males and 10 (38.5%) were female subjects, with mean age of 39 ± 11.4 years (41.4 ± 11.8 and 36.2 ± 13.3 years, respectively,  $p = 0.001$ ); the clinical manifestations, laboratory findings, and thoracic CT findings of these 26 patients are summarized in tables 1, 2 and 3, respectively.

**Table 1.** Clinical manifestations in 26 patients with 2009 H1N1 virus infection

Signs and symptoms at the admission	Percent
Respiratory symptoms*	91.6%
Fever	88.4%
Myalgia	65.7%
Tachycardia	36.5%
Tachypnea	32.4%
Diarrhea	14.8%
Vomiting	13.8%

\*Cough, sore throat, rhinorrhea

**Table 2.** Laboratory findings in 26 patients with 2009 H1N1 virus infection

Laboratory finding	Value
Median blood O <sub>2</sub> saturation	90%
Median co <sub>2</sub> pressure	30
Percent of lymphopenia <sup>a</sup>	28%
Mean of platelet count	192090 ± 115764.4 <sup>b</sup>
Mean of white blood cell count	10777 ± 12307 <sup>b</sup>
Mean of hemoglobin	11.9 ± 2.76 g/dl
Mean of ESR	39.9 ± 36.2 mm/hour
Mean of blood PH	7.33 ± 0.1
Blood culture	Negative
Sputum culture <sup>c</sup>	Negative

<sup>a</sup> <1000 lymphocytes per cubic millimeter

<sup>b</sup> cells per cube millimeter

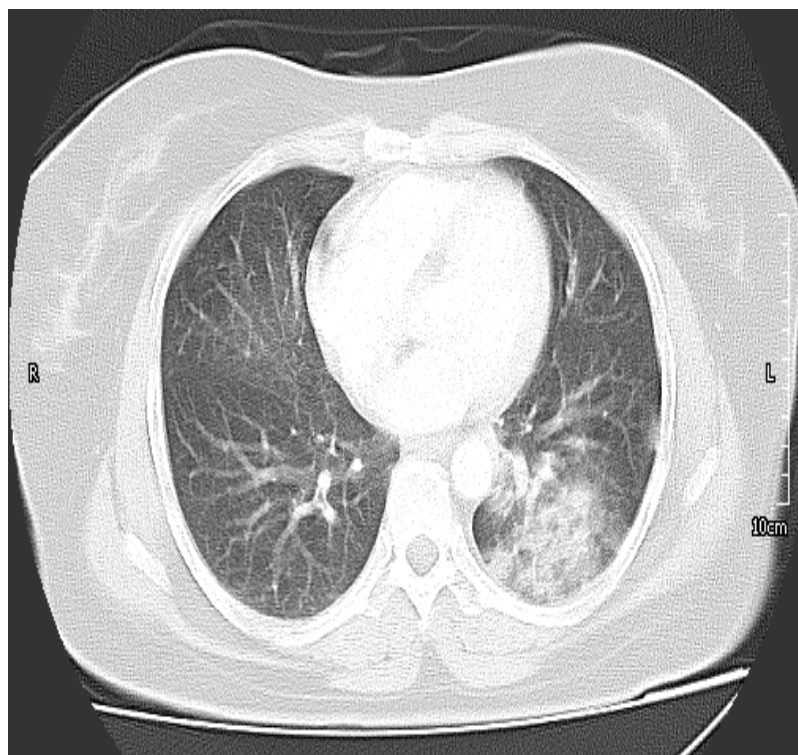
<sup>c</sup> if available

**Table 3.** Thoracic computed tomography (CT) findings in 26 patients with 2009 H1N1 virus Infection

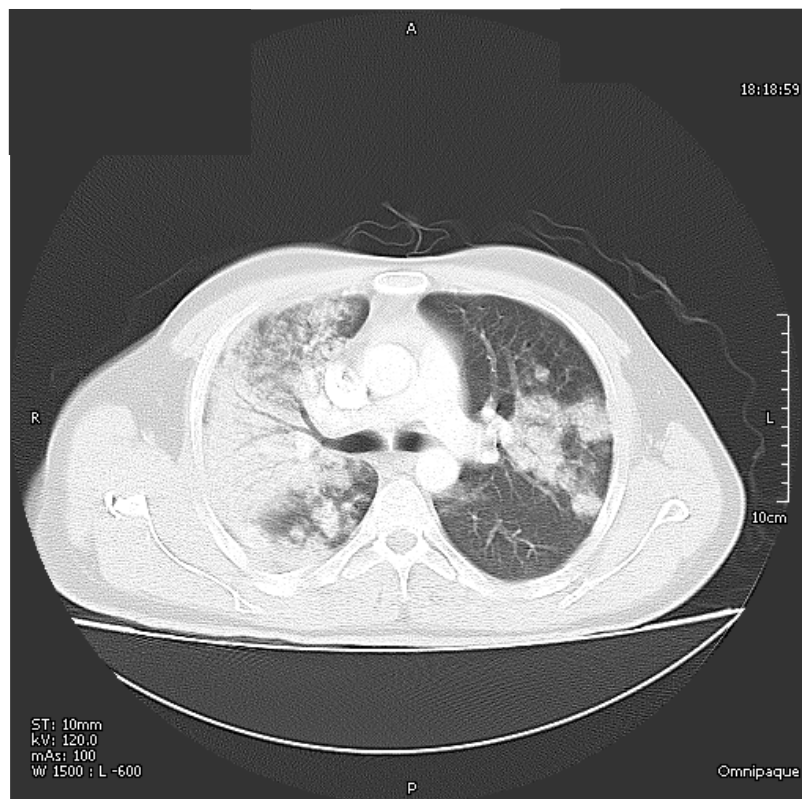
Findings	Number (Percent)
Adenopathy	1 (3.8%)
Distribution	
Unilateral	2 (7.7%)
Bilateral	21 (80.8%)
Pleural	
Unilateral	2 (7.7%)
Bilateral	6 (23.1%)
Lobar consolidation	8 (30.8%)
Airbronchogram	10 (38.5%)
Diffuse alveolar	5 (19.2%)
Patchy	9 (34.6%)
Interstitial	7 (26.9%)
Cavity	1 (3.8%)
Ground-glass	1 (3.8%)
Subpleural	5 (19.2%)
Peribronchial/Central	3 (11.5%)
Tree-in-Bud	0 (0%)



**Figure 1.** Thoracic CT of a 35-year-old man with 2009 H1N1 influenza virus infection. Cavitory lesions and empyema are seen.



**Figure 2.** Thoracic CT of a 32-year-old woman with 2009 H1N1 influenza virus infection. Ground-glass opacities increased bronchovascular markings, and left lower lobe ill-defined consolidation is seen.



**Figure 3.** Thoracic CT of a 40-year-old man with 2009 H1N1 influenza virus infection. Patchy infiltrations and alveolar consolidations with air bronchograms are seen.

In chest radiographs, 55% of the patients had abnormalities indicating the pneumonia, including 75% with bilateral infiltrates and 24% with unilateral infiltrates. The major radiological abnormalities observed on chest X-rays were interstitial changes (46.2%). Pleural effusion was seen in 28.8% of the chest X-rays taken during the hospitalization, and infiltrations were predominantly in lower lobes (48.6%). Some of the thoracic CT scans of our patients selected randomly are shown in figures 1, 2, and 3.

### Discussion

Patchy infiltration (34.6%), lobar consolidation (30.8%), and interstitial infiltration (26.9%) with airbronchogram (38.5%) were the predominant findings in our patients. Bilateral distribution was seen in 80.8% of the subjects. We did not identify any significant predominant anatomic distribution of lung parenchymal abnormalities in our patients.

There was no study about the thoracic CT findings in 2009 H1N1 in Iran in the literature.

In the study of Agarwal et al<sup>7</sup> in the United States, the most frequent pattern of abnormality was bilateral alveolar disease, with lower and central lung preponderance. These findings were not in accordance with the present study.

In the study of Ajlan et al<sup>8</sup> in Canada, hazy areas of increased opacity without obscuration of the underlying vessels (ground-glass opacities) were the most common findings, which were more commonly bilateral than unilateral. These findings also were not in accordance with the present study.

The differences of the results of aforementioned studies with our study can be due to different rates of bacterial super-infection, different time of taking CT or immunologic differences between patients.

In the study of Karadeli et al<sup>11</sup> in Turkey, the most common imaging findings for lung involvement were a mixture of air-space consolidation and ground-glass opacity with a patchy pattern and lower/middle zone predominance. Patterns of lung involvement in this study were in accordance with the present study.

Ground-glass opacities and consolidations were the predominant radiographic finding in some other reports<sup>4,12,13</sup> and severe acute respiratory syndrome (SARS).<sup>14</sup>

In brief, the most common thoracic CT finding in pandemic 2009 H1N1 in this study were patchy infiltration, lobar consolidation, and interstitial infiltration with airbronchogram and bilateral distribution. While these findings can be associated with other infections; they may be indicating 2009 influenza A (H1N1) in the appropriate clinical setting. A high index of suspicion for influenza should be maintained occasionally; it may have an appearance identical to bacterial pneumonia. Various radiographic patterns can be seen in thoracic CT

scans of the influenza patients. Imaging findings were nonspecific.

This study had several limitations. First, it was a retrospective study included only a few numbers of subjects, and thus, it is difficult to make a definite statement about the most common thoracic CT manifestations of 2009 H1N1 in general. Second, none of the patients underwent lung biopsy or autopsy which could predict radiographic-histopathologic correlation. Third, influenza A infections are not uncommonly complicated by superinfection with other organisms, particularly bacterial; so it is possible that some of the findings seen on CT scans performed are due to an infection other than influenza.

### Conflict of Interests

Authors have no conflict of interests.

### Authors' Contributions

MR, AAJ, FK, KM, AA, AN, MM, HS, MA, AE, MRY and FR have planned study and collection specimen and supervised the project with association of BA. BA and MRY have planned the study and prepared the first version the manuscript. AB statistical analysis and prepared the first version of manuscript. BA, MR, AAJ, MA and MRY prepared the final version the manuscript.

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