Original Article

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CT Findings in Pediatric Novel Influenza A (H1N1)-Associated Pneumonia

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Abstract

Objective: To explore CT findings in pediatric novel influenza A (H1N1)-associated pneumonia

Methods: We examined the CT findings in a series of six children with influenza H1N1-associated pneumonia.

Findings: In this series of cases, the predominant CT patterns were consolidations surrounded by ground glass opacities (GGOs) as well as isolated GGOs in all patients. Atelectasis was present in the right upper lobe (n=2) in three cases and pneumomediastinum in two.

Conclusion: In this series of cases, there may be no imaging differences between pediatric and reported adult influenza H1N1 cases and other viral pneumonia cases even with CT. Pneumomediastinum and atelectasis, especially in the right upper lobe, may frequently present in influenza H1N1-associated pneumonia as well as in other pediatric respiratory diseases.

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Key Words: Influenza A; H1N1; Pneumonia; Children; CT Scan

Introduction

Since the reports of sustained person-to-person infections with a novel influenza A (H1N1) virus in Mexico and the United States in April 2009, H1N1 influenza virus has now spread worldwide [1]. As of 5 February 2010, more than 209 countries and territories or communities across the world have reported laboratory-confirmed cases of pandemic influenza H1N1, involving at least 15,174 deaths [2]. The most common causes of death from influenza H1N1 were viral pneumonia [3]. There have been some reports describing the imaging features of novel influenza A (H1N1)-associated pneumonia [4-8]. However, the only report covering children evaluated plain chest radiographic findings [8]. To our knowledge, no reports have appeared focusing on CT features in pediatric cases. The purpose of our study was to investigate the preliminary CT findings in novel influenza H1N1-associated pneumonia in children.

Subjects and Methods

The study included a consecutive series of six Novel influenza A (H1N1)-associated pneumonia in children who underwent CT between October

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and December 2009. The influenza H1N1 and pneumonia were both confirmed by the polymerase chain reaction test of nasopharyngeal swabs, physical findings and chest radiographs. Sputum culture examinations to detect the coinfected pathogens were negative in all cases. All children required admission to our hospital for high fever and respiratory distress. The mean age of the five boys and one girl was 9.0±2.0 years. The average body temperature, white blood cell count and C-reactive protein were, respectively, 40.0±0.6ºC, 12,783±777.8/μL and 7.5±1.9 mg/dL. All children were treated with antivirals (oseltamivir or zanamivir) and antibiotics with or without corticosteroids, after which they recovered and were discharged a few weeks after admission.

The CT scanner used in this study was a 4-detector-row CT scanner (Asteion; Toshiba Medical Systems, Tokyo, Japan). The scanning parameters were: 120 kVp, 90–115 mA, 4×2-3-mm collimation, 0.75s rotation time, 6 helical pitch, 28–32cm field of view, 512×512 matrix size. Scan data were reconstructed at slice thicknesses and intervals of 5-7mm and displayed with lung (window width 1500 HU; level –650 HU) and mediastinal (window width 350 HU; level 40 HU) settings.

The predominant patterns, namely, consolidation (homogeneous opacification of the parenchyma with obscuration of the underlying vessels), ground-glass opacities (GGOs: hazy increased attenuation without obscuration of the underlying vessels) and consolidation mixed with GGOs were initially reviewed independently by two experienced radiologists. Atelectasis and its location were observed, and nodules/masses, reticular opacities, mediastinal/hilar adenopathy (≥1 cm in short-axis diameter), pleural effusion, pneumothorax and pneumomediastinum were also seen. The distribution of lung abnormalities was found to be of several patterns, namely, unilateral or bilateral, symmetric or asymmetric, focal (having a single focus of abnormality) or multifocal (with more than one focus of abnormality), patchy (showing multifocal abnormalities but separated from the normal lung parenchyma) or diffuse (exhibiting continuous and extensive involvement), predominantly peripheral (involving mainly the subpleura of the lung) or central (involving mainly the perihilum of the lung), or peribronchial (involving mainly the peribronchium) or not peribronchial. The extent of lung abnormalities (the percentage of lung involvement in both lungs) was observed subjectively. The investigators had no knowledge of the relevant clinical data, and any differences of evaluation were discussed until a consensus was reached.

Findings

Chest CT was performed on admission day 0 or 1 for evaluation of complications of pneumonia, because the patients had severe respiratory distress.

In this series of cases the CT findings of all cases (n=6) were abnormal. In all cases, the predominant CT pattern of the lung lesions was mixed: a combination of consolidation and GGOs (Fig. 1). The consolidation was surrounded by GGOs in all cases. However, there were also GGOs located by themselves (n=5) (Fig. 2). Atelectasis was seen in three cases, located in the right upper lobe (n=2) and in the left upper lobe (n=1).

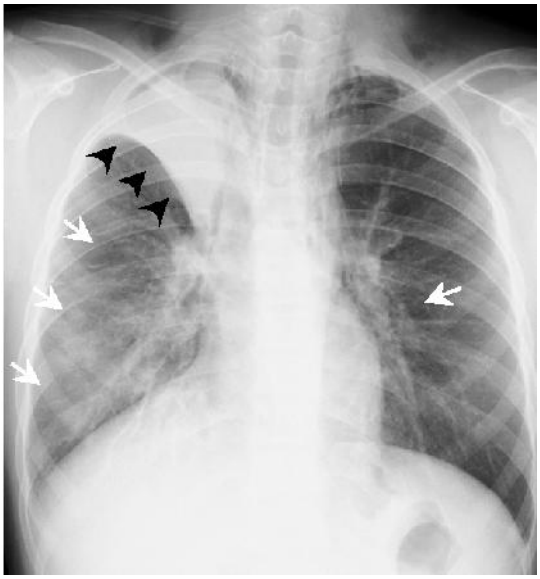

Fig. 1: In a 9-year-old boy requiring hospitalization for high fevers and respiratory distress, a CT showing bilateral consolidation surrounded by ground glass opacity (GGO) (arrows). Right pleural effusion is also present (arrowhead).

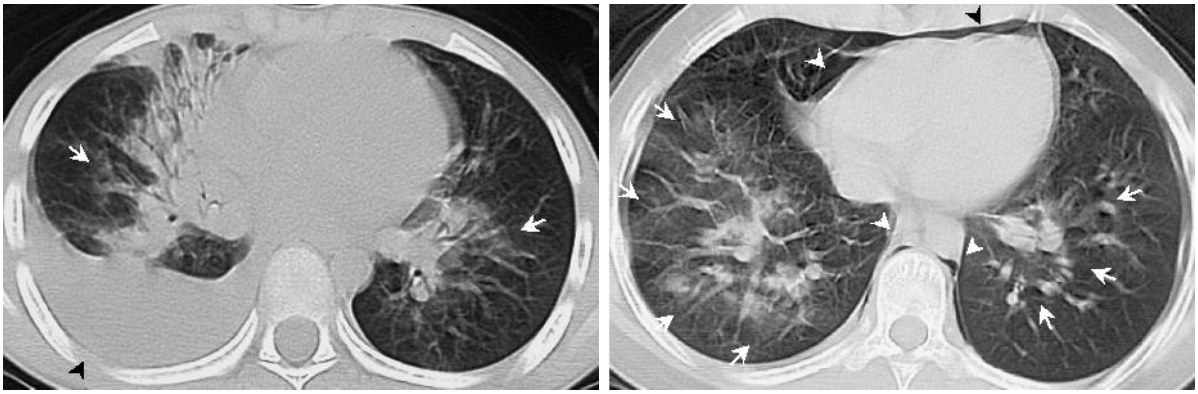

Fig. 2: In an 11-year-old girl requiring hospitalization for high fever and respiratory distress, (a) a chest radiograph shows atelectasis of the right upper lobe (arrowheads), GGOs with a bilateral, asymmetric, perihilar and peribronchial distribution and pneumomediastinum (arrows); and (b) a CT shows bilaterally and peribronchially distributed GGOs (arrows). Pneumomediastinum is also present (arrowheads).

Nodules, masses, reticular opacities, mediastinal or hilar adenopathy and pneumothorax were not seen in any case. Pleural effusion was seen in two cases (one moderate and the other mild) and was unilateral (one right and one left). Resolution occurred without puncture. Pneumomediastinum was present in two cases. The distributions of lung abnormalities were bilateral (n=3) or unilateral (n=3), and were asymmetric, multifocal, patchy, predominantly perihilar and peribronchial in all cases. The average extent of the lung abnormalities was 50±20% (ranging from 35 to 70%). All of these findings were resolved after antiviral treatment.

Discussion

The CT findings of all were abnormal in this series of cases. Agarwal et al[5] reported that chest radiographs were normal in more than half of the patients with novel influenza A (H1N1), most of whom were outpatients. These outpatients were considered mild cases. Ajlan et al[5] and Lee et al[9] reported similar results. In the present study, CT was performed in more severe cases whose chest radiographs were abnormal, then all cases were abnormal. Although the frequency of abnormal chest CTs in novel influenza H1N1 was not determined in this study, it may be considered that chest CT showed more abnormal findings in severe cases.

In this study, the predominant CT findings were: consolidation surrounded by GGOs, and GGOs alone. Pleural effusion was seen in two cases. Nodules, masses, reticular opacities, mediastinal or hilar adenopathy and pneumothorax were not seen. These results were similar to those in other reports of adults and young adults[4-7]. To our knowledge, only one report has appeared regarding chest radiographic findings of novel influenza H1N1 in children[8], in which Lee et al stated that initial chest radiographs in children with a mild and self-limited clinical course of novel influenza H1N1 infection were often normal, but they may demonstrate prominent peribronchial markings with hyperinflation. Bilateral, symmetric, and multifocal areas of consolidation, often associated with GGOs, were the predominant radiographic findings in pediatric patients with a more severe clinical course of novel influenza H1N1 infection. Therefore, there may be no differences of image findings between adults and children even with CT. In our study, the GGOs were also located by themselves in most cases because of higher contrast resolution of CT than radiographs. As described in the previous reports regarding novel influenza H1N1-associated pneumonia and other viral pneumonitis, CT may show small GGOs in the early phase of pneumonia, and in the advanced phase, these lesions may progress to form

extensive dense alveolar opacities as the infection advances, even without associated bacterial infection, although a variety of CT appearances is found in the course of pneumonia [4-9].

In this study of children, atelectasis was frequently presented, especially in the right upper lobe. There have been no reports describing atelectasis in novel influenza H1N1-associated pneumonia in adults and children. Thomas et al [10] described that multiple factors may act synergistically to increase the risk of atelectasis in the infant's lung. Peroni et al[11] reported similar statements. Furthermore, the high incidence of upper lobe and, especially, right upper lobe collapse in the neonatal intensive care setting is well described[12]. The reasons for this difference are suggested to be the following: a) mucus may be occluding a bronchus or bronchiole in an infant because the size of the airways is smaller in infants; b) the collateral pathways of ventilation (pores of Kohn and canals of Lambert), which help to prevent collapse distal to the airway occlusion in the adult, are less well developed in children; c) forceful expiration in an infant which raised intrathoracic pressure may compress the lower trachea and bronchi because pediatric airways are more collapsible in response to pressure changes; d) the airways of children contain a higher concentration of mucus glands than adults e) aspiration of secretions will preferentially involve the right upper lobe because this lobe's bronchus is the most dependent in the supine child[13]. Therefore, atelectasis, especially in the right upper lobe, may present frequently in pediatric novel influenza A (H1N1)-associated pneumonia as well as other respiratory conditions in children.

In this study pneumomediastinum was seen in two cases. Hasegawa et al[14] reported two occurrences of spontaneous pneumomediastinum complicating pneumonia in children infected with novel influenza H1N1. There have been no other reports describing pneumomediastinum in influenza H1N1-associated pneumonia. Lee et al[15] reported a peak in the incidence of pneumo-mediastinum occurring in children, but they did not state the causes of the condition. There is a possibility that pneumomediastinum is frequent complication of influenza H1N1-associated pneumonia because of the weakness of a child's airway, as in other respiratory diseases in children.

Pleural effusion was present in two cases in our study without sputum culture evidence of superimposed bacterial pneumonia. There have been reports stating that pleural effusion was not observed in any novel influenza H1NI-associated pneumonia[6,8]. However, there have been reports of observation of pleural effusion in some patients[4,5]. Not many reports have described the imaging features of novel influenza H1NI-associated pneumonia, and yet these were investigated with radiographs, not CT. Lee et al [8] stated that small pleural effusion could have gone unrecognized in frontal radiographs. Agarwal et al[5] stated that tiny pleural effusion on CT was not appreciable on radiographs. Therefore pleural effusion, especially mild, may not be uncommon finding in novel influenza H1NI-associated pneumonia, even without evidence of superimposed bacterial pneumonia.

A limitation of our study of a series of cases is that the number of cases covered was small. Although it may not be possible to explain the precise characteristics of CT findings of H1N1-associated pneumonia in just six children, this report should trigger studies of radiological findings of H1N1-associated pneumonia in children because no reports, to our knowledge, have appeared focusing on CT features in pediatric cases. Evaluation of large numbers of cases is needed to establish CT findings in pediatric novel influenza H1N1-associated pneumonia after careful consideration of the indications of CT.

Conclusion

We investigated the CT findings in six pediatric cases of novel influenza A (H1N1)-associated pneumonia. The results were preliminary, and the predominant CT patterns in this series of cases were consolidation surrounded by GGOs, and GGOs that were present alone. There may be no image differences between adult and pediatric influenza H1N1 and other viral pneumonias even with CT. Pneumomediastinum and atelectasis,

especially in the right upper lobe, may present frequently in pediatric influenza H1N1-associated pneumonia as well as in other respiratory diseases in children.

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Conflict of Interest: None

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