Original Article

Radiographic Features of SARS in Paediatric Patients: A Review of Cases in Singapore

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Abstract

Introduction: Severe acute respiratory syndrome (SARS) is a newly emerged atypical pneumonia caused by the SARS-associated coronavirus (SARS-CoV). Chest radiographic appearances have been reported as non-specific, ranging from normal to peribronchial thickening and ill-defined airspace shadowing. This study is a retrospective review of chest radiographic findings in children with suspected and probable SARS during the 2003 outbreak in Singapore. Materials and Methods: We focused on children admitted to the SARS treatment ward from March 2003 to May 2003. Chest radiographs of children admitted with suspected or probable SARS as well as other febrile illness during this period were retrospectively and independently reviewed by 3 radiologists. The radiographs were randomised and anonymised before interpretation. Subsequently, we identified the radiographs of patients who were categorised as suspected or probable SARS. We present our findings in these patients' radiographs. Results: A total of 67 patients' serial chest radiographs were interpreted. Of these, we subsequently selected those patients with suspected or probable SARS for analysis. The radiographic abnormalities in suspected or probable SARS patients consisted of patchy ground glass opacities or patchy airspace consolidation. The abnormalities had a predominantly lower zone distribution on chest radiographs, followed by mid-zone involvement. There was a slight preponderance of peripheral zone involvement. There was equal distribution of abnormalities in both lungs. All the children with radiographic abnormalities made uneventful recoveries and had normal radiographs on follow-up review. Conclusions: In children, SARS appears to have a relatively mild and non-specific pattern of respiratory illness. The radiographic features in children with suspected or probable SARS in our study were comparable to other clusters of paediatric patients during initial presentation. It is difficult to distinguish SARS in children from other viral pneumonias on radiographic features alone. Positive travel history to endemic regions or positive contact history, and laboratory findings of lymphopaenia, leukopaenia and thrombocytopaenia are important clues.

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Key words: Children, SARS-CoV, Viral pneumonia

Introduction

Severe acute respiratory syndrome (SARS) is a newly emerged atypical pneumonia caused by the SARS-associated coronavirus (SARS-CoV). It is easily transmitted via droplet infection from close contact. The World Health Organization (WHO) criteria for the diagnosis of SARS requires positive clinical and radiographic features as well as travel/contact history or positive laboratory tests for SARS-CoV.[1] The first documented outbreak was in Guangdong Province, southern China in November 2002. A pandemic involving 29 countries and territories lasted until July 2003, with more than 8000 probable cases and 774 deaths. The overall global case fatality ratio was 9.6%.[2] In Singapore, the first index case was a traveller returning from Hong Kong, who was admitted to hospital on 1 March 2005. Subsequently, 238 probable cases were reported in Singapore, with 33 deaths (case fatality ratio of 14%).[2] Fewer than 10 patients with probable SARS were under the age of 10 years, and another 10 probable cases were under the age of 20 years.[1]

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In children, SARS appears to have a relatively mild and non-specific pattern of respiratory illness,[3,4] making radiographic and laboratory findings important in reaching a positive diagnosis. The presence of fever and positive exposure history appear to be important initial clues. Lymphopaenia, neutropaenia and thrombocytopaenia also appear to be common findings.[3,4] Chest radiographic appearances have been reported as non-specific, ranging from normal to peribronchial thickening and ill-defined airspace shadowing.[5,6]

Diagnosis of SARS in children remains a challenge that requires close cooperation between paediatricians, radiologists and public health specialists. This study is a retrospective review of chest radiographic findings in children with suspected and probable SARS during the 2003 outbreak in Singapore. We describe the radiographic findings and their correlations with other paediatric viral illnesses as well as adult SARS features.

Materials and Methods

In Singapore, Tan Tock Seng Hospital was designated as the SARS treatment centre in 2003, and a special paediatric unit was formed to look after the children admitted with suspected or probable SARS. Children up to the age of 12 years were admitted to a single ward. The children were classified into suspect (S), probable (P) and observe (O) categories (Table 1). In addition, children with respiratory symptoms and fever from other causes were also referred to the institution, and those requiring observation or treatment were admitted to the wards.

Clinical data and radiographs of children admitted to the SARS ward from March 2003 to May 2003 were retrospectively reviewed. The cases included those with suspected or probable SARS, as well as those with other respiratory illnesses admitted during this period. Chest radiographs of the children admitted during this time (n = 67) were available for review. As this was a retrospective review, the patients had already been recategorised according to suspected and probable SARS case definitions. The radiographs were anonymised and randomised by one of the paediatricians managing the SARS ward and given to 3 specialist radiologists for interpretation. A standard form was used to document the radiographic abnormalities. Lung abnormalities were classified into lobar consolidation, patchy consolidation, interstitial thickening or patchy ground glass opacities. The distribution of lung abnormalities was classified into upper, mid or lower zones and further sub-classified into central or peripheral zones.

Subsequently, the radiographs of suspected and probable SARS patients (n = 28) were identified by the authors and reviewed for the patterns of abnormal findings. Chest radiograph findings of the children with suspected (n = 21) or probable (n = 7) SARS were reviewed from the time of admission to follow-up at 1 month after discharge. The age of the patients ranged from 7 months to 12 years. Fifteen were male and 13 were female.

Results

We found that 8 of the 28 (29%) children reviewed with suspected or probable SARS had an abnormal chest radiograph on initial admission. Of this cohort of 8 patients, 4 were diagnosed as probable SARS and the other 4 were categorised as suspected SARS. A ninth probable SARS patient subsequently developed radiographic abnormalities. The remaining children had normal radiographs during admission and on follow-up.

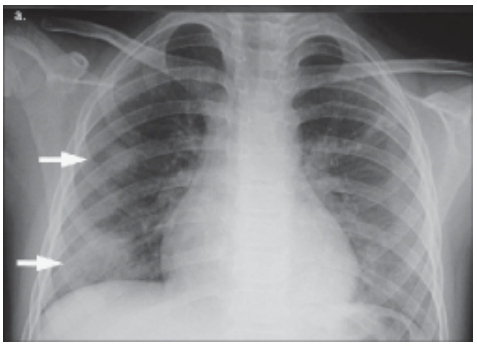
The radiographic abnormalities in the positive radiographs (n = 9) consisted of patchy ground glass opacities (n = 7) and patchy consolidation (n = 4). Interstitial thickening, lobar consolidation or cavitation was not seen on chest radiographs in these patients. Hilar lymphadenopathy and pleural effusions were also absent in the abnormal chest radiographs we reviewed. The abnormal findings in the chest radiographs also showed a predominantly lower zone distribution (n = 8), followed by mid-zone involvement (n = 6) (Fig. 1). Upper zone involvement was seen least commonly (n = 2). The lung abnormalities were more commonly seen in the peripheral zones (n = 8) than the central zones (n = 6). Of the patients with chest radiograph abnormalities, 5 had bilateral lung involvement (Fig. 2). The right lung alone was involved in 2 patients and another 2 patients showed left lung involvement.

Table 1. Case Definitions for SARS

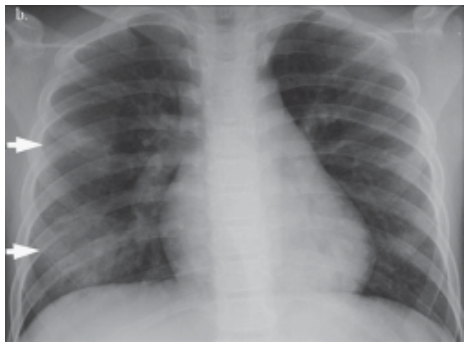
	Clinical features		**Travel/Contact history**
Suspect SARS	Fever (>38°C) *and* Cough or breathing difficulty	And	Positive travel history* *or* Close contact history in preceding 10 days
Probable SARS	Fever (>38°C) *and* Cough or breathing difficulty *and* X-ray changes of pneumonia *or* RDS *or* Autopsy findings of RDS without an identifiable cause	And	Positive travel history* *or* Close contact history in preceding 10 days *or* Positive PCR or serological test for coronavirus (by WHO/US CDC criteria)

PCR: polymerase chain reaction; RDS: respiratory distress syndrome; SARS: severe acute respiratory syndrome; WHO: World Health Organization; US CDC: United States Centers for Disease Control

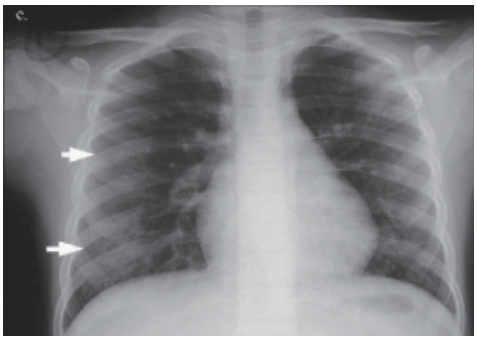
* Positive travel history: Travel in the previous 10 days to SARS-affected areas as listed by the World Health Organization. The case definition for SARS includes both clinical features and travel/contact history.



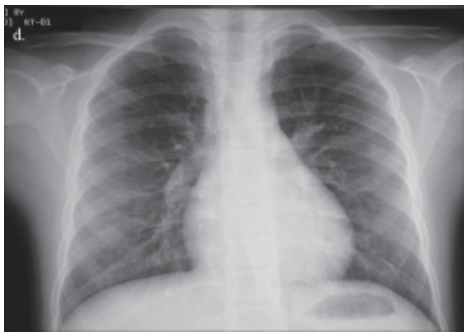
a. On admission, Day 6 of illness. Right peripheral mid and lower zone ground glass opacities (arrows).



b. On Day 8 of illness. Interval stability of the pulmonary opacities.

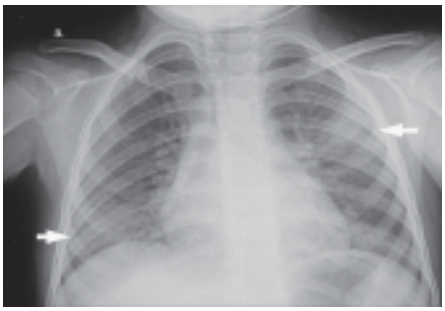


c. On discharge, Day 13 of illness. Lung opacities are still present. Patient was afebrile for 3 days prior to discharge.

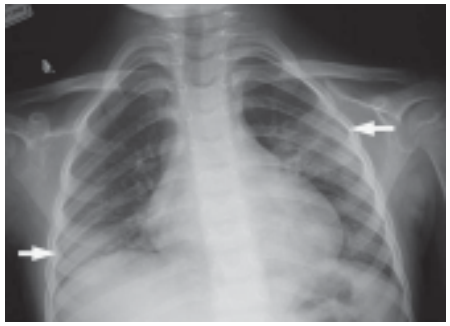


d. On follow-up, 35 days after onset of symptoms. There is complete resolution of the pulmonary opacities.

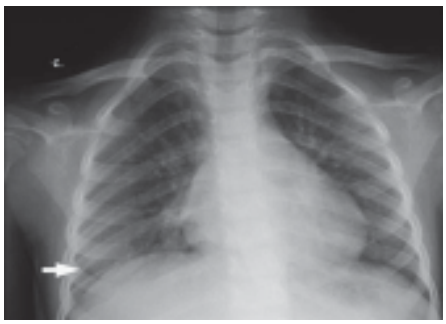
Fig. 1. A 9-year-old Chinese girl presented with a 5-day history of fever. Serial radiographs illustrate the commonly seen peripheral unilateral lung involvement.



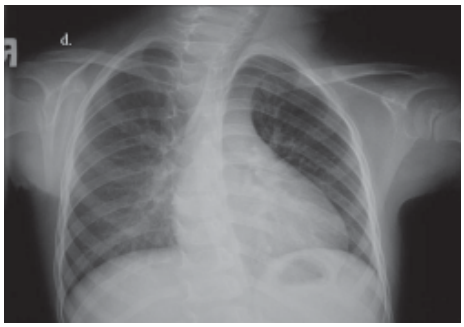
a. On admission, Day 8 of illness. Right peripheral lower and left peripheral mid zone ground glass opacities (arrows).



b. On Day 11 of illness. Increased opacification of the pulmonary lesions.



c. On discharge, Day 18 of illness. The right lower zone opacity is still faintly seen. Patient was afebrile for 3 days prior to discharge.



d. On follow-up, 35 days after onset of symptoms. There is complete resolution of the ground glass opacities.

Fig. 2. An 8-year-old Chinese girl presented with a 4-day history of fever. Serial radiographs illustrate the less commonly seen bilateral lung involvement.

The radiographic abnormalities showed resolution at 1 month follow-up after discharge. No residual lung parenchymal scarring was evident. None of the children reviewed in this study had undergone high-resolution computed tomography (HRCT) for further assessment of the lung parenchyma.

The children with abnormal radiographic features had a spectrum of respiratory symptoms including cough, sore throat, rhinorrhoea and fever, but none required mechanical ventilation or admission to intensive care units. There were no deaths amongst the paediatric patients and all made an uneventful recovery and were asymptomatic on follow-up review.

Discussion

Viral pneumonias in children are caused by several pathogens, including respiratory syncytial virus (RSV), adenovirus and parainfluenza virus. In addition, SARS-CoV will be an important consideration if a symptomatic child has positive travel or contact history. The radiographic features of the affected children appear to be wide-ranging and non-specific in these children, making it difficult to distinguish the causative pathogen. Pneumonia secondary to RSV is known to manifest with peri-bronchial thickening, infiltrates and hyperinflated lungs.[7] Adenovirus infections present with patchy or extensive consolidations.[8] In recent years, avian influenza type A/H5N1 has been confirmed in children in several outbreaks in East Asia and Eastern Europe.[9] However, not enough data is available to ascertain the radiographic abnormalities seen. There appears to be a more severe form of viral pneumonia in children with confirmed avian influenza type A/H5N1.[10]

Our findings appear similar to the radiographic features seen in children with SARS in other clusters around the world.[5,6] The paediatric SARS patients we reviewed had a relatively mild and non-specific clinical course of the illness and all made uneventful recoveries. This is in contrast to the case fatality ratio of 14% in adult patients in Singapore.[1] The children in our centre, with suspected or probable SARS, did not require mechanical ventilation or intensive care management, in contrast to adult patients, where 20% needed intensive care unit admission and mechanical ventilation.

The majority of the patients we reviewed presented with fever. The clinical features of the children with SARS did not have many distinguishing features from other viral illnesses, and the helpful findings appear to be relatively exaggerated lymphopaenia, leukopaenia and thrombocytopaenia,[3] as well as abnormal chest radiographic findings. Bitnun et al[4] found that in the children with suspected or probable SARS in Toronto, reverse-transcriptase polymerase chain reaction (RT-PCR) analysis of nasopharyngeal specimens seemed to be of little utility for the diagnosis of SARS during the early symptomatic phase of this illness. Tsou et al[5] reviewed a cluster of 4 children with SARS, which confirmed a milder course of the disease and clinical course compared to the adults. Ill-defined air space shadowing was a common radiographic finding in the patients reviewed. Babyn et al[6] reviewed radiographic features of 62 children with suspected and probable SARS in clusters around the world. They found non-specific radiographic features, making radiological differentiation difficult.

In the patients we reviewed, none had undergone HRCT of the thorax. Leung et al[11] described their findings in 44 children with SARS in the Hong Kong outbreak, where they found HRCT features of focal sub-pleural consolidation in 2 patients who had normal chest radiographs. The HRCT of children they reviewed who received oxygen therapy showed persisting minor ground glass opacities or air trapping on expiration.

There is also no documented case of SARS in neonates born to women with confirmed SARS. Shek et al[12] described a case series of 5 infants of mothers with SARS and none of the infants developed SARS. In addition, similar to adult patients with SARS, the children in our review did not have radiographic changes of hilar adenopathy, lobar consolidation, cavitations or pleural effusions.[13,14]

Conclusion

We reviewed a series of radiographs in children with suspected or probable SARS in Singapore. A third of these patients had abnormal radiographic findings on initial admission. The radiographic abnormalities consisted of patchy ground glass opacities or patchy air space consolidation. The abnormalities had a predominantly lower zone distribution on chest radiographs, followed by mid-zone involvement. There was a slight preponderance of peripheral zone involvement. There was also equal distribution of abnormalities in both lungs in the radiographs. Half of the children with abnormal radiographs had bilateral lung involvement. All the children with radiographic abnormalities made uneventful recoveries and had normal radiographs on follow-up review.

Although the numbers in our review are small, the radiographic features in children with suspected or probable SARS in our study were comparable to the other clusters of paediatric patients during initial presentations. Similar to adult patients with SARS, the children did not have radiographic changes of hilar adenopathy, lobar consolidation, cavitations or pleural effusions. However, the children had a relatively mild and non-specific course of illness compared to adults.

It is difficult to distinguish SARS in children from other

viral pneumonias on radiographic features alone. Radiographic abnormalities of patchy ground glass or airspace opacities in the lower zones and in a peripheral distribution appear to be the predominant findings. RT-PCR tests for SARS-CoV may not be useful in the early stages of the illness. Positive travel history to endemic regions or positive contact history, and laboratory findings of lymphopaenia, leukopaenia and thrombocytopaenia are helpful findings.

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