POINT OF CARE LUNG ULTRASOUND IN CHILDREN WITH COVID-19: A CASE SERIES

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Abstract

Background: Lung ultrasound (US) proved useful in patients with COVID-19, but limited data are available about its use in affected children. Aim: Lung ultrasound (US) is in the front door in the assessment of patients with coronavirus disease 19 (COVID-19), but limited data are available about its use in affected children. We aimed to describe lung US features and discuss its potential applications in COVID-19 children considering the usually mild disease course. Methods: We performed lung US to children with COVID-19 admitted between March 1st and April 27th, 2020. Clinical and radiological data were collected. One or more subsequent lung US were obtained from all subjects. Results: A series of 13 confirmed COVID-19 children were recruited. 8/13 patients showed signs of respiratory interstitial syndrome as for focal or coalescent B-lines or white lung, also in the absence of relevant clinical symptoms. Conclusions: As clinical characteristics of pediatric COVID-19 differ from adults, it is of interest to determine whether pediatric lung US shares the same imaging pattern of adults and whether COVID-19 pneumonia may differ from other virus pneumonia. Our small series highlighted that lung US documented signs of interstitial pneumonia in paucisymptomatic or asymptomatic pediatric patients. In conclusion, we pinpoint the usefulness of point of care lung US for the evaluation of infected children correlated with clinical information.

Introduction:

The emergence of a novel coronavirus (SARS-CoV-2) from Wuhan, China, has spread rapidly across the globe and on March 11th, 2020 World Health Organization (WHO) proclaimed pandemic.[1-2] By May 27th, 2020, a total of 231,030 coronavirus disease 19 (COVID-19) cases were confirmed in Italy. Of the affected patients, 2,1% were children under 18 years of age with 4 associated deaths.[3] While data are available for adult patients with COVID-19, limited reports analyze pediatric patients infected with SARS-CoV-2.[1,2]Children comprise a small fraction of COVID-19 cases, and their symptoms are often mild. Frequent clinical manifestations include fever, dry cough, and fatigue accompanied by other upper respiratory symptoms. In a few cases, nausea, vomiting and diarrhea were reported, particularly in infants. In general, pediatric COVID-19 has a good prognosis with recovery within 1 to 2 weeks after disease onset, although, at present, there is lack of data on the role of comorbidities.[1-2,4-6] Some children may progress to severe disease, and initial atypical presentations may delay the diagnosis leading to unfavorable outcomes.[5-6]

Chest imaging is in the front door in the diagnostic approach to any patient with respiratory symptoms during this COVID-19 outbreak.[7] Over the last weeks, there has been a considerable amount of publications on the possible use of lung ultrasound in adults with COVID-19,[7-11] but limited data on a small samples of 8 and 10 patients are available about its use in affected children.[12-13] Indeed, point of care ultrasound (POCUS) of the lung may inform the diagnosis, prognostic stratification and disease evolution, thus guiding

the clinical decision-making and management of patients with COVID-19.[8-9] In adults, SARS-CoV-2 typically induces an interstitial diffuse bilateral pneumonia with asymmetric and patchy lesions distribution, mainly involving the lung periphery, represented by bilateral separate or coalescent B-lines. B-lines are interstitial artifactual signs, described as hyperechoic vertical artifacts arising from the pleural line or small peripheral consolidations, moving in concert with lung sliding and erasing A-lines. Confluent B-lines appearing as a "white lung" are equivalent to ground-glass opacities on computed tomography (CT) scan, suggesting a more severe loss of lung aeration. With disease progression, these patterns subsequently extend to multiple areas of the lung surface.[7-10] Whether pediatric COVID-19 shares the same imaging pattern of adults is an important issue but, to our knowledge there is just one report describing ultrasonographic features of pediatric patients with COVID-19.[12]

We present a series of 13 hospitalized confirmed COVID-19 pediatric cases in which lung US was performed aiming to describe lung US features in children and discuss the potential applications of lung US in COVID-19 children considering the usual asymptomatic/mild disease course.

Materials and Methods:

An observational study including children (<18 years) admitted to the Pediatric Unit at Meyer Children University Hospital (Florence, Italy) for documented COVID-19 from 1st March to 27th April, 2020, was performed. Clinical charts data on contact history and previous history, clinical symptoms, coinfections (defined as a concurrent infection of a patient with two or more pathogens simultaneously) and radiological examinations (chest X-ray or CT scan) were gathered. Nasopharyngeal swab samples of all the subjects were collected, and SARS-CoV-2 RNA was identified by reverse transcription-polymerase chain reaction. One or more subsequent lung POCUS were obtained from all subjects by two expert pediatricians with specific POCUS training, during the routine daily medical examination. All the images were stored and blinded reviewed by an experienced POCUS emergency medicine pediatrician with 10 years POCUS experience, to provide agreement within lung US reports. The study protocol was approved by the Ethics Committee of Meyer Children's Hospital and parental informed consent was obtained. Lung US was performed with a portable laptop-size POCUS machine using a linear probe (L12-4s mHz). In order to minimize the risk of device contamination and subsequent nosocomial spread, the US machine and the probe were each covered in a sterile plastic. The operator entered the isolation room, using personal protective equipment (PPE) as for WHO recommendations, with the US machine on a sanitizable tray and performed both the clinical examination and lung US. At the end of the procedure, the operator took off the covers and the PPE in a dedicated clean room and subsequently sterilized probe, wire, machine and tray. The thorax was scanned in 6 lung areas to provide a focused and rapid picture of involvement of key regions of the lung: anterior, lateral and posterior, bilaterally.[14] In our Institution lung ultrasound is routinely included in the management of patients with respiratory conditions. Lung US features were evaluated 'a priori' as follows (Figure1): (a) A-lines pattern; (b) focal separate B-lines; (c) focal coalescent B-lines; (d) confluent B-lines appearing as a "white lung"; (e) subpleural consolidations (dimension < 1 cm) associated with single or coalescent B-lines; (f) consolidations (dimension > 1cm); (g) pneumothorax; (e) pleural effusion.[15]

Results:

Thirteen pediatric inpatients (10 female) with confirmed COVID-19, were included. All of our cases were exposed to an infected family member. Epidemiological and clinical features are described in Table 1. Age ranged from 1 month to 14 years (median 4 years). The clinical manifestations included fever in all symptomatic cases (10/13), respiratory symptoms (cough, nasal discharge, croup) in 5/13 cases, and gastrointestinal symptoms in 2 infants, variably associated. Three patients (23%) were asymptomatic and were admitted to hospital because of comorbidities. Except for a single case of respiratory syncytial virus (RSV) coinfection, none of the included patients required oxygen or assisted ventilation. Specific treatment for COVID-19 was administered in 2 patients with oncological comorbidity. At least one or repeated lung US were performed in all 13 patients; 3 patients underwent chest-X-ray (#6, #8, #12) and one patient underwent CT scan (#10). Lung US pattern of our patients is shown in Table 2. Lung US documented artifacts of respiratory interstitial syndrome as for focal or coalescent B-lines or white lung in 8/13 patients

and a normal A-pattern was found in 5/13 patients. Among asymptomatic cases, 2 patients showed normal A-pattern whereas patient #6, affected by subglottic stenosis, showed posterior bilateral B-lines. Patient #2, which tested positive for RSV coinfection, showed B-lines and subpleural consolidation. No patient presented pneumothorax or pleural effusion. The time interval between symptoms onset and lung US did not seem to affect US pattern. Six patients were repeatedly examined with lung US on alternate days in order to follow the evolution, without substantial variations on ultrasonographic pattern. Just in one case (#1), lung US repeated 4 days after admission showed improvement of the interstitial patterns. Concordance between lung US and CT scan and X-ray findings was found in 3 patients (#6, #10, #12), when performed at the same time.

Agreement between physician sonographers and the expert sonographer's blind review was 100%. The 10 symptomatic patients recovered within 2 to 10 days; no deaths were reported.

Discussion:

Lung US represents a promising method to detect lung abnormalities in adults with COVID-19 pneumonia and its pattern correlates with radiological findings.[8-10] At present, only one recent report describes lung US findings in children, reporting high concordance between radiologic and lung US imaging.[12]In China, where the COVID-19 epidemic started, many children underwent chest X-ray and CT scan of the lung as part of the local diagnostic protocols.[5-6,16] The main radiologic findings on CT scan in children with COVID-19 (bronchial thickening, ground-glass opacity, inflammatory lung lesions) were suggestive of pneumonia and were found also in patients with mild symptoms or asymptomatic.[16-17] It could be argued that despite the mildness of respiratory symptoms, several children underwent chest CT.[6,16] Biologic effects of ionizing radiations are widely known and it is mandatory for pediatricians to choose wisely the best radiologic options balancing clinical conditions and possible adverse events correlated to the diagnostic test.[18] As the majority of children with COVID-19 present mild symptoms and complications are rare, CT scan could be reserved to the few severe or complicated pediatric cases. Further to the radiological issues, the risk of transporting COVID-19 patients for CT scan followed by the mandatory decontamination procedure and the risk of nosocomial spread makes this form of imaging risky and time consuming. The diagnostic role of US in several respiratory conditions in children is nowadays widely documented.[19] In this COVID-19 outbreak scenario, we pinpoint the usefulness of lung US for the evaluation of infected children. The avowed advantages of lung POCUS in terms of bedside evaluation, absence of radiation, low cost, no need for sedation and the possibility of repeating the examination during follow-up should be exploited and implemented.[19-20] Moreover, the possibility of performing lung US by a single operator at the bedside, minimize the need of transferring the patient, consistently reducing the potential risk of further infection spreading within the healthcare personnel.[11] Our small series highlighted that lung US clearly documented signs of interstitial pneumonia in a considerable proportion of pediatric patients, which were paucisymptomatic or asymptomatic. When performed, lung US pattern correlated with radiological findings. On subsequent repeated lung US, we found similar findings, but observational time might have been too scarce as patients were mostly discharged a few days after admission. More data are needed to explore whether time interval between symptoms onset and lung US execution modifies ultrasonographic findings. The power of lung US in orientating the management of patients is increased by its correlation with clinical information. Despite the small sample described in our series, we found that lung US can show signs of interstitial pneumonia also in the absence of relevant clinical symptoms. This did not significantly affect clinical management of the patients; therapeutic choices were mostly determined by risky comorbidities. A possible limitation to the spread of lung US is the lack of specific standardized and certified training on lung US. [19-20]

The current rapid worldwide spread of SARS-CoV-2 infection requires continual improvement of knowledge about clinical manifestations of COVID-19. As clinical characteristics of pediatric COVID-19 differ from adults, it is of interest to determine whether pediatric lung US shares the same imaging pattern of adults, and whether COVID-19 pneumonia may differ from other virus pneumonias. It could be argued that lung US may be of particular need in guiding therapeutic choices especially for moderate to severe cases. Our study represents a preliminary report of lung US characteristics and usefulness in children affected by COVID-19.

Implementation of LUS during the COVID-19 outbreak is of great interest.

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