



Imaging in support of the clinical diagnoses of COVID-19 and multisystem inflammatory syndrome in children

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Received: 8 January 2021 / Revised: 21 January 2021 / Accepted: 3 February 2021 / Published online: 17 February 2021
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The coronavirus disease 2019 (COVID-19) pandemic has dramatically changed the way we practice pediatric radiology. Not only are we practicing in entirely new ways with increased physical separation from both our colleagues and our patients, but we need to be attuned to the imaging findings of an entirely new disease and its complications. The impact of COVID-19 on the pediatric population is not as severe as it is in at-risk adult populations [1, 2]. However, infection occurs in children and can have a variety of manifestations including the multisystem inflammatory syndrome in children (MIS-C) [3].

In this issue of *Pediatric Radiology*, Dr. Fenlon and colleagues [4] from Columbia University report their experience with 47 children and young adults with clinically diagnosed COVID-19-associated MIS-C. They described a spectrum of imaging findings, many of which are subjective, across a variety of imaging modalities, with the general picture being one of leaky vasculature and third-spacing of fluid. These findings included peribronchial thickening, pleural effusions in younger (<10 years of age) children, small-volume ascites, and gallbladder and bowel wall thickening. While some children had the characteristic multifocal pulmonary opacities seen in adults with COVID-19, no imaging appearance was characteristic or diagnostic for MIS-C.

In the February issue of *Pediatric Radiology*, Dr. Rostad and colleagues [5] from Emory University described their

experience with 37 children with either COVID-19 or COVID-19 and symptoms meeting the Centers for Disease Control case definition for MIS-C. Their results differed somewhat from those of Fenlon et al. [4] on the specific pulmonary manifestations of MIS-C and the frequency of those manifestations. For example, Rostad et al. reported pleural effusions to be much more ubiquitous. However, Rostad et al.'s results again suggest a general picture of third-spacing of fluid including pleural effusions, basal predominant lung opacities and reactive changes in the abdomen.

While both series described the imaging manifestations of MIS-C to be more severe than those described for COVID-19 alone, neither adjusted for disease acuity/severity or resuscitation status. As such, the distinction between the disease and complications of management of the disease is blurred. Are the findings reported specific manifestations of MIS-C? Or are they sequelae of aggressive resuscitation? Or both? In prior reports emphasizing the pulmonary manifestations of MIS-C in children, Blumfield et al. [6] and Winant et al. [7] described the occurrence of pulmonary emboli, which have been more extensively described in adult cohorts. Those authors considered acute respiratory distress syndrome (ARDS) to be a manifestation of MIS-C, which they postulated to be a post-viral syndrome related to autoimmunity and post-viral inflammation (“cytokine storm”). In total, it is unclear what the relation of MIS-C is to aggravation of primary COVID-19 pneumonia, potentially complicated by pulmonary embolic disease from coagulopathy, and the effects of longstanding mechanical ventilation, fluid resuscitation and superimposed hospital-acquired infections on the lung parenchyma, all of which manifest as ARDS.

In the early phases of the COVID-19 pandemic, when there was significant and growing uncertainty about the availability of diagnostic testing, there was some thought that imaging might play a role in diagnosis, particularly of characteristic lung disease. However, findings that are believed to be characteristic (i.e. highly prevalent in a population of confirmed cases) might not be all that specific for disease (i.e. predict the

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presence of COVID-19 in a general population presenting with the variety of symptoms). As experience with COVID-19 and imaging has grown, it has become clear that imaging does not play a primary diagnostic role because of its suboptimal sensitivity and specificity [8, 9]. The results of the two studies recently published in *Pediatric Radiology* similarly suggest that imaging does not play a primary diagnostic role for the identification of MIS-C.

The studies by Fenlon et al. [4] and Rostad et al. [5] add to the growing list of publications in *Pediatric Radiology* and other journals on imaging findings of COVID-19 and MIS-C in children. Given that the general picture emerging is that there is no imaging appearance specific to this disease complex, what is the message for practicing pediatric radiologists? Should we invoke COVID-19 or MIS-C each time we see any of the described nonspecific and often subjective findings on imaging, particularly during the fall and winter respiratory virus season? Doing so would generate false-positives and unnecessary workups without clear clinical benefit. Based on what has been published to date, the focus of imaging should not be to diagnose COVID-19 (or MIS-C) based on so-called characteristic imaging findings but instead to exclude other processes and complications that impact patient management.

Declarations

Conflicts of interest None

References

1. Caro-Dominguez P, Shelmerdine SC, Toso S et al (2020) Thoracic imaging of coronavirus disease 2019 (COVID-19) in children: a series of 91 cases. *Pediatr Radiol* 50:1354–1368
2. Li W, Cui H, Li K et al (2020) Chest computed tomography in children with COVID-19 respiratory infection. *Pediatr Radiol* 50:796–799
3. Shelmerdine SC, Lovrenski J, Caro-Dominguez P et al (2020) Coronavirus disease 2019 (COVID-19) in children: a systematic review of imaging findings. *Pediatr Radiol* 50:1217–1230
4. Fenlon EP III, Chen S, Ruzal-Shapiro CB et al (2021) Extracardiac imaging findings in COVID-19-associated multisystem inflammatory syndrome in children. *Pediatr Radiol*. <https://doi.org/10.1007/s00247-020-04929-1>
5. Rostad BS, Shah JH, Rostad CA et al (2021) Chest radiograph features of multisystem inflammatory syndrome in children (MIS-C) compared to pediatric COVID-19. *Pediatr Radiol* 51:231–238
6. Blumfield E, Levin TL, Kurian J et al (2020) Imaging findings in multisystem inflammatory syndrome in children (MIS-C) associated with COVID-19. *AJR Am J Roentgenol* 216:507–517
7. Winant AJ, Blumfield E, Liszewski MC et al (2020) Thoracic imaging findings of multisystem inflammatory syndrome in children (MIS-C) associated with COVID-19: what radiologists need to know now. Radiological Society of North America website. <https://pubs.rsna.org/doi/full/10.1148/ryct.2020200346>. Accessed 28 Jan 2021
8. Raptis CA, Hammer MM, Short RG et al (2020) Chest CT and coronavirus disease (COVID-19): a critical review of the literature to date. *AJR Am J Roentgenol* 215:839–842
9. Waller JV, Kaur P, Tucker A et al (2020) Diagnostic tools for coronavirus disease (COVID-19): comparing CT and RT-PCR viral nucleic acid testing. *AJR Am J Roentgenol* 215:834–838

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