

Received:
29 April 2020

Revised:
24 August 2020

Accepted:
03 September 2020

Cite this article as:

Carroll AG, Quinn N, Byrne C, Kassab G, Whelan S, Colleran GC. Pneumomediastinum in a child with severe COVID-19. *BJR Case Rep* 2020; 7: 20200062.

CASE REPORT

Pneumomediastinum in a child with severe COVID-19

¹ANNE G CARROLL, MB BCh BAO, MRCSI, MSc, FFRCRCSI, ²NUALA QUINN, MBChB, BSc (Hons), MSc, FRCPI, ³CARL BYRNE, MB, BCh, BAO, ¹GHADIR KASSAB, MBBCh, FFRCRCSI, FRCR, ⁴SIOBHAN WHELAN, MB BCh BAO, MRCPi and ¹GABRIELLE C COLLERAN, MB BCh BAO, IMRCS, MD, FFR RCSI

¹Department of Radiology, Children's Health Ireland at Temple Street, Dublin, Ireland

²Emergency Department Research Group, Murdoch Children's Research Institute, Melbourne, Australia

³Department of Paediatric Emergency Medicine, Children's Health Ireland at Temple Street, Dublin, Ireland

⁴Department of Intensive Care Medicine, Children's Health Ireland at Temple Street, Dublin, Ireland

Address correspondence to: Dr Anne G Carroll
E-mail: annegcarroll@gmail.com

Anne G Carroll and Nuala Quinn have contributed equally to this study and should be considered as co-first authors.

SUMMARY

The current global pandemic of the novel coronavirus SARS-CoV2 is a threat to the health and lives of millions of people worldwide. The latest statistics from the World Health Organisation show that there have been 6,515,796 confirmed cases worldwide with 387,298 confirmed deaths (last update 5 June 2020, 10:41 CEST). The majority of critically unwell patients with SARS-CoV2 are adults and the radiological findings associated with them are consistent throughout the literature. However, the reported paediatric cases are few, and as such, there is a limited body of evidence available. More international data is needed, not only on the clinical presentation, but also the radiological findings, so that health-care providers are better able to understand and diagnose this pandemic disease. We describe a case of a previously healthy 9-year-old female who presented to the Emergency Department with symptoms suggestive of raised intracranial pressure. Her CT revealed a medulloblastoma and post-operatively she tested positive for SARS-CoV2. She had a rapid deterioration in her clinical condition and required admission to the intensive care unit (ICU). We provide the supporting radiology along her clinical course in order to demonstrate important insights into this disease in children, including the unusual pneumomediastinum complications which occurred as part of her clinical course. This case is the first reported of its kind.

INTRODUCTION

The impact of the current global pandemic of the novel coronavirus SARS-CoV2 has been unprecedented in modern history. It has placed a huge diagnostic and management burden on hospitals worldwide. The latest statistics from the World Health Organisation show that there have been 6,515,796 confirmed cases worldwide with 387,298 confirmed deaths (last update 5 June 2020, 10:41 CEST). The literature has been rapidly expanding. There is a growing body of evidence around the COVID-19 associated radiological findings. We know that adults are more likely than children to become critically unwell. Affected adults who develop acute respiratory distress syndrome (ARDS) need aggressive ventilatory support, develop multiorgan failure and may remain in intensive care units for weeks. Many health-care systems have a shortage of intensive care unit (ICU) and ventilator capacity during this pandemic. In contrast, what we know about SARS-CoV2 in children

is limited. There is a paucity of paediatric evidence in the published literature and more case reports are needed. We describe a case of a 9-year-old female with a newly diagnosed medulloblastoma who tested positive for SARS-CoV2 post-operatively at the time of an acute respiratory deterioration. We provide the accompanying radiology along her clinical course.

CASE PRESENTATION

Our patient is a previously healthy 9-year-old female who presented to her local ED with sudden onset headache and drowsiness and a reduced Glasgow Coma Scale (GCS 12–14). A CT scan of her brain was performed which showed a large hyperdense midline lesion centred on the fourth ventricle with associated obstructive hydrocephalus and transependymal oedema. She had no past medical history, was afebrile and had no respiratory symptoms. Her family had no known sick contacts. Shortly after CT, she

Figure 1. Axial T_2 weighted image of the posterior fossa which demonstrates a mildly T_2 hyperintense midline mass in the fourth ventricle, subsequently confirmed on histology to be a medulloblastoma.

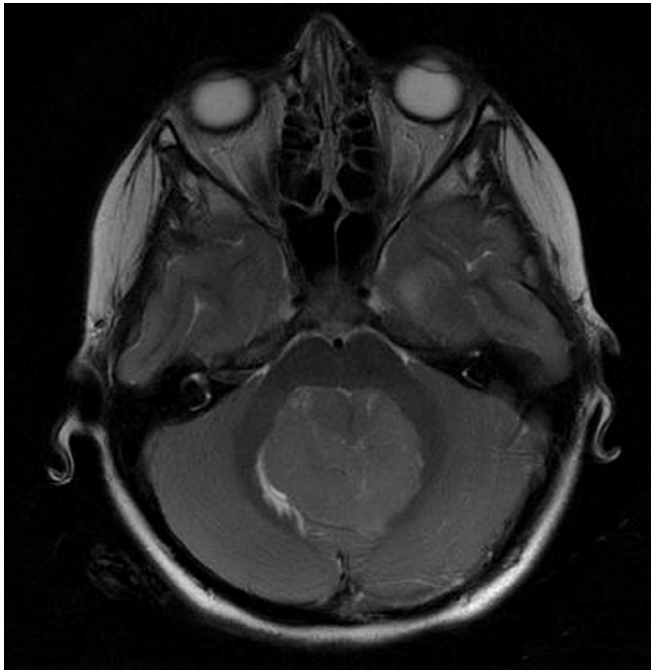
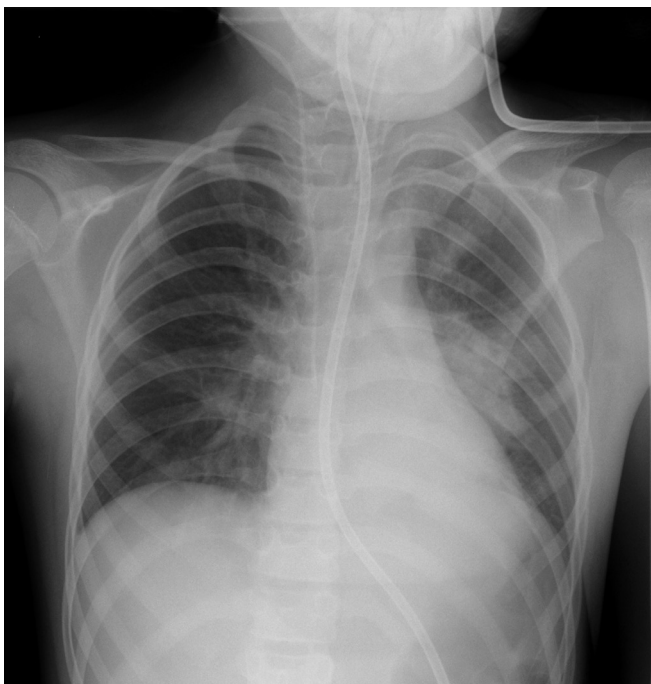


Figure 2. Day 2 post-operative. Allowing for some rotation of the patient, CXR shows new airspace opacification in the left mid zone and left lower lobe, consistent with pneumonia and atelectasis. CXR, chest X-ray.



deteriorated and became unconscious requiring endotracheal intubation by rapid sequence induction. She was immediately transferred to our tertiary paediatric neurosurgical centre with a new diagnosis of a posterior fossa tumour.

Shortly after her arrival to our hospital, Children's Health Ireland at Temple Street, she had an external ventricular drain (EVD) inserted in theatre and was commenced on intravenous dexamethasone 2 mg bd (weight 26 kg). She underwent a MR scan of her brain, which demonstrated an enhancing, T_2 hyperintense midline mass centred on the fourth ventricle (Figure 1) demonstrating reduced diffusivity. This was suspicious for a medulloblastoma. The initial post-EVD insertion course was uneventful and she was extubated successfully.

2 days later (Day 3) she underwent a suboccipital craniectomy and subtotal resection of tumour. Her pre-operative chest X-ray (CXR) was normal. She had minimal blood loss during the surgery and post-operative MRI revealed no evidence of vascular insult. Given the significant cerebral oedema intraoperatively, it was decided to delay dural and skull closure. Histological analysis of the resected tumour revealed a malignant small round blue cell tumour. Immunohistochemistry demonstrated a synaptophysin positive profile. Histological and radiology findings conclude that the lesion was a non-WMT non-SHH medulloblastoma.

Her post-op extubation was deferred due to copious thick secretions and high ventilatory requirements during her operation. A bronchoscopy demonstrated thick secretions bilaterally, which were suctioned leading to a clinical improvement. Endotracheal aspirates showed no bacterial growth. CXR showed pneumonia and atelectasis in the left mid zone and left lower lobe (Figure 2). She was extubated the following day. At that time, her respiratory examination demonstrated mild reduced air entry to the left lower lobe and mild bilateral wheeze. A SARS-CoV2 swab was sent. She remained afebrile. At this time, her full blood count (FBC) and C-reactive protein (CRP) were within normal limits.

The swab was reported positive for SARS-CoV2 the next day. Two days after (Day 5 post-operative), there was a marked deterioration in her clinical status. She became tachypnoeic and had an increase in the severity and production of her cough. She had frequent episodes of hypoxia (SpO_2 76%) despite being on high flow nasal oxygen. She became neutrophilic during this initial deterioration. Neutrophils were elevated at 13.34. Her lactate dehydrogenase (LDH) and coagulation profile also were significantly deranged with her LDH, prothrombin time and activated partial thromboplastin time elevated at $1028 U l^{-1}$, 14.0s and 22.0s respectively. Her FiO_2 was increased to 35% and nebulised salbutamol was administered. Despite these interventions, her oxygen requirements increased to FiO_2 50%. Large volumes of thick secretions were noted. CXR showed progression of confluent airspace opacities in both mid and lower zones and also new pneumomediastinum (Figure 3). She was admitted to the ICU. Despite the large volumes of secretions, cultures from samples taken during bronchoalveolar lavage (BAL) did not demonstrate any clear bacterial growth, with commensal bacteria being identified at counts $< 10,000 \mu/l$.

Figure 3. Day 5 post-operative. CXR shows interval progression of confluent airspace opacities in both mid and lower zones. The patient developed pneumomediastinum at this point. Note subcutaneous emphysema tracking along the left side-of the neck. CXR, chest X-ray.

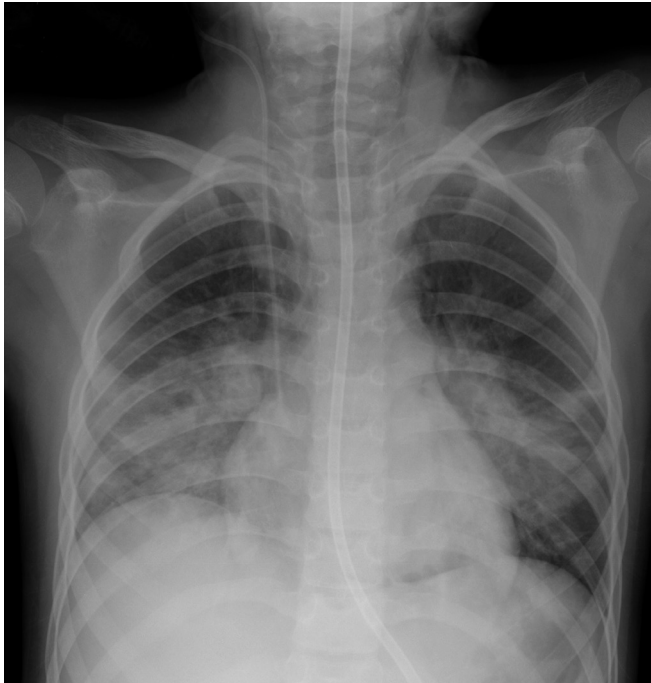
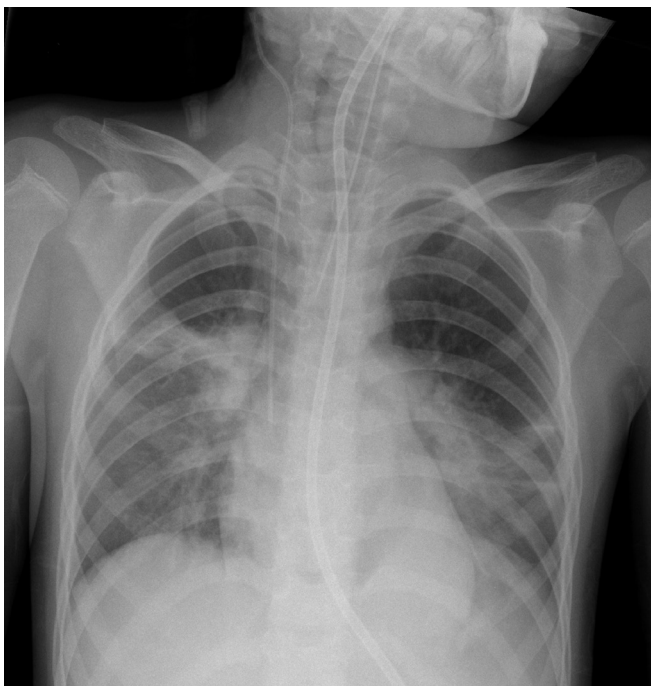


Figure 4. Day 7 post-operative. CXR shows improved aeration of the right lower zone with progressive airspace opacity in the right mid zone. Pneumomediastinum is still present. CXR, chest X-ray.



Over the subsequent days she became more hypoxic, with frequent episodes of desaturation to 80%. She was re-intubated on Day 7 post-operatively. There was a significant increase in thick purulent respiratory secretions which were removed under bronchoscopy. CXR showed development of new airspace opacity in the right mid zone (Figure 4).

The patient remained ventilated for 25 days. She required increasing ventilatory support and was having episodes of hypoxia, with reduction in SpO₂ to 89%. Her radiography was consistent with this deterioration, with progression of right mid- and lower zone airspace opacities (Figure 5) and development of recurrent pneumomediastinum (Figure 6). Clinical examination at this time revealed mildly reduced air entry bilaterally with some transmitted sounds. Her blood profile was now abnormal with an elevated white cell count ($20.3 \times 10^9/l$) and C-reactive protein 203 mg l^{-1} .

She had a contrast-enhanced CT thorax which demonstrated bilateral parahilar infiltrates and bilateral dependant consolidation in keeping with ARDS. There was diffuse ground glass opacity in the right lung with relative peripheral sparing, but no significant ground glass opacity in the left lung (Figure 7).

There followed a slow improvement. She responded well to prone positioning. Her ventilator settings were reduced and there was significant reduction in endotracheal secretions. Her inflammatory markers normalised. Her clinical condition improved and she was extubated 4 days later (post-operative Day 29).

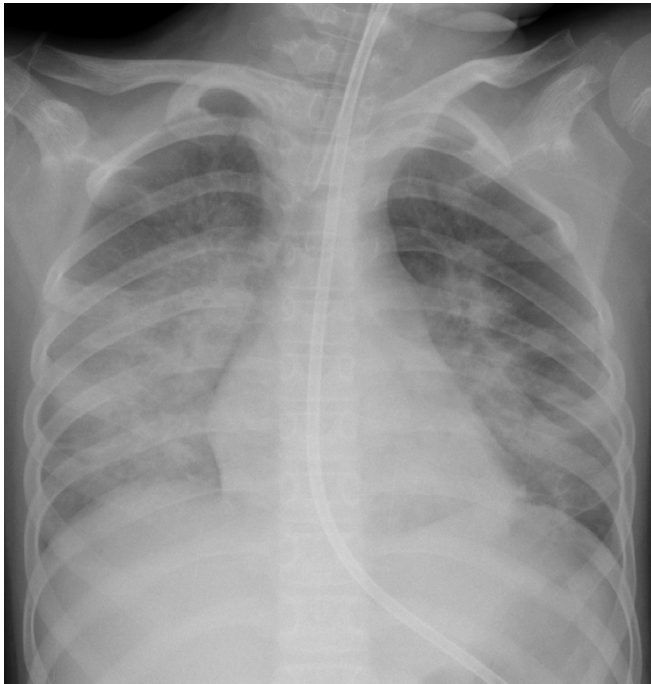
She made a slow clinical recovery over the subsequent number of weeks. A follow-up high resolution CT Thorax performed 6 weeks after the initial CT Thorax showed bilateral peribronchovascular linear densities, suggestive of persistent inflammatory changes and possible early fibrosis (Figure 8). She will continue to have respiratory follow-up. She went on to commence chemotherapy and radiotherapy for further treatment of her medulloblastoma.

DISCUSSION

To date, there has been limited evidence published regarding the presentation, clinical course and imaging findings in children infected with COVID-19. Many children appear to be asymptomatic. Some present with fever, cough, sore throat, respiratory distress or gastrointestinal symptoms. Severe COVID-19 infection requiring ICU admission appears to be much less common in children than in adults.¹⁻⁶ Imaging findings in children range from normal CXR and CT thorax, to findings similar to adults, including ground glass opacities, consolidation and appearances typical of ARDS.^{3,7,8} The incidence of peribronchial thickening and parahilar distribution of infiltrates appears to be more common in children compared with adults, with the typical subpleural ground glass opacities seen in adults less prevalent in children.⁸

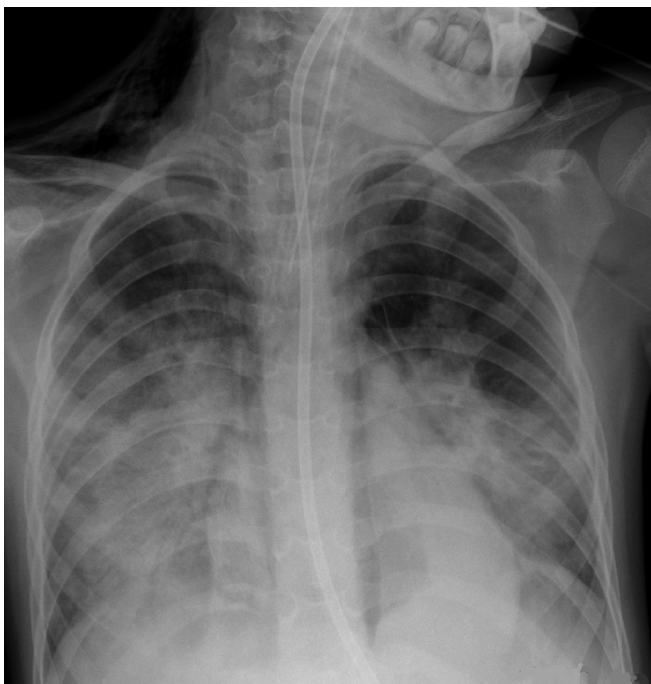
Our patient had no respiratory signs or symptoms when she presented to the ED with symptoms of her brain tumour. Her initial CXR showed normal appearance of both lungs. Her

Figure 5. Day 13 post-operative. CXR shows progression of right mid and lower zone airspace opacities. The left lung appearance is stable. CXR, chest X-ray.



respiratory symptoms only started in the early post-operative period after neurosurgical resection of a medulloblastoma. Serial chest radiography demonstrated worsening consolidation, initially in a parahilar distribution, with a changing “fleeting”

Figure 6. Day 16 post-operative. CXR shows stable air space opacification bilaterally. The child has developed recurrent pneumomediastinum, while intubated. CXR, chest X-ray.



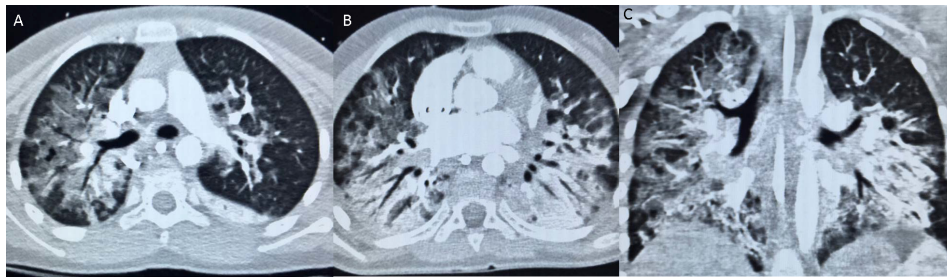
distribution of consolidation on serial radiographs, as well as the development of pneumomediastinum. She progressively deteriorated, requiring mechanical ventilation. Her CT thorax subsequently demonstrated ground-glass opacities and dependent consolidation consistent with ARDS, as is commonly seen in severe COVID-19.

It is possible that this patient’s COVID-19 infection may have been more severe after having undergone major surgery, as has been reported in some small case series around the world.^{9–11} She received 14 days of steroid treatment for raised intracranial pressure pre- and post-resection of a medulloblastoma. There is emerging evidence of the beneficial effect of steroid treatment on patients with COVID-19. The possibility of a concurrent bacterial infection was a concern following the patient’s initial deterioration post-operatively. BAL cultures demonstrated no clear bacterial co-infection, with growth of commensals at counts of <10,000 µ/l from her initial BAL. Three further BAL cultures demonstrated no bacterial growth over the subsequent fortnight despite the prevalence of copious secretions during the procedure.

An unusual aspect of this case is the occurrence of pneumomediastinum on two separate occasions; initially when the patient first clinically deteriorated prior to intubation and transfer to ICU and the second episode occurred later in the clinical course when the patient was ventilated in the ICU. Pneumothorax or pneumomediastinum have been rarely reported in Covid-19 patients and, to our knowledge, only in adults.^{5,12} Interestingly, Zhou *et al* described a case report of a 38-year-old male in Wuhan who was on steroids at the time of pneumomediastinum, although he was also ventilated at the time.¹² This case is similar to another case report of a 38-year-old male reported by Sun *et al* who presented on the same day to the same hospital in Wuhan¹³; given the similarities in age and location and temporal association, it is thought possible that these publications may represent the same patient. Chen *et al* report one case of a patient with pneumothorax also in Wuhan in January 2020, but no further details are provided.⁵

We hypothesise that alveolar damage secondary to coronavirus infection may be the aetiology behind the possible association with pneumothorax and pneumomediastinum in severe COVID-19. However, larger case series would be necessary before association could be confirmed and there is currently insufficient evidence to demonstrate causation. We feel that it is unlikely that pneumomediastinum was due to mechanical ventilation or otherwise iatrogenic in this patient as the initial pneumomediastinum occurred during a period of self-ventilation with no air leak evident on the preceding CXR (Figure 2) and no new central lines were inserted in that interval. Atelectasis is a common finding in post-operative paediatric patients, but the unusual distribution of airspace opacification and the presence of pneumomediastinum in this patient alerted the reporting radiologist to consider COVID-19, prior to the patient’s swab result being available. Given our experience in the setting of community transmission of COVID-19,

Figure 7. A–C: Day 26 post-operative. Contrast-enhanced helical CT Thorax, KV 100, MA148, 2mm slice thickness performed under general anaesthesia. Paediatric dose reduction as per patient weight.



we recommend that the presence of spontaneous pneumomediastinum should cause the clinician to consider the diagnosis.

CONCLUSION

This case provides a detailed insight into the clinical presentation and radiological features of a child with severe COVID-19 infection, including an atypical presentation with pneumomediastinum during a period of self ventilation. Further research is needed to demonstrate association and possible causation.

LEARNING POINTS

- During the current pandemic, beware of possible COVID-19 infection in previously asymptomatic patients who suddenly clinically deteriorate in the post-operative period.
- COVID-19 infection may be more severe in children who become infected in the immediate pre-operative or perioperative period, as has been seen in adults.

Figure 8. Follow-up high resolution CT Thorax obtained 6 weeks after CT. KV 100 MA 60, paediatric dose reduction. Axial image on lung windows demonstrates bilateral linear opacities in a peribronchovascular distribution, right side worse than left. The appearances are suggestive of persistent inflammatory changes and possible early fibrosis.



- Air leak complications such as spontaneous pneumomediastinum may be associated with COVID-19 infection. Case reports are merely hypothesis generating. More research is needed to study this possible association.

ACKNOWLEDGEMENTS

The authors give sincere thanks to our patient's parents for giving informed consent to publish this case report and images. We are grateful to them and offer our thoughts to them at this extremely difficult time

CONTRIBUTORS

Dr Carroll and Dr Collieran conceptualized and designed the study, and reviewed and revised the manuscript. Dr. Carroll performed a literature review.

Dr Quinn drafted the initial manuscript and reviewed and revised the manuscript.

Dr Byrne collected the data, reviewed and revised the manuscript.

Dr Kassab provided the radiographic figures and legends, and reviewed and revised the manuscript.

Dr Whelan analysed and interpreted the data, reviewed and revised the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

COMPETING INTERESTS

The authors have no conflicts of interest to disclose.

FUNDING

None

PATIENT CONSENT

Written informed consent was obtained from the patient's parents for publication of this case report, including accompanying images.

DISCLOSURE

The authors have no financial relationships relevant to this article to disclose

REFERENCES

1. Qiu H, Wu J, Hong L, Luo Y, Song Q, Chen D, et al. Clinical and epidemiological features of 36 children with coronavirus disease 2019 (COVID-19) in Zhejiang, China: an observational cohort study. *Lancet Infect Dis* 2020; **20**: 689–96. doi: [https://doi.org/10.1016/S1473-3099\(20\)30198-5](https://doi.org/10.1016/S1473-3099(20)30198-5)
2. Pathak EB, Salemi JL, Sobers N, Menard J, Hambleton IR. COVID-19 in children in the United States: intensive care admissions, estimated total infected, and projected numbers of severe pediatric cases in 2020. *J Public Health Manag Pract* 2020; **26**: 325–33. doi: <https://doi.org/10.1097/PHH.0000000000001190>
3. Lu X, Zhang L, Du H, Zhang J, Li YY, Qu J, et al. SARS-CoV-2 infection in children. *N Engl J Med Overseas Ed* 2020; **382**: 1663–5. doi: <https://doi.org/10.1056/NEJMc2005073>
4. Dong Y, Mo X, Hu Y, Qi X, Jiang F, Jiang Z, et al. Epidemiology of COVID-19 among children in China. *Pediatrics* 2020; **145**: e20200702. doi: <https://doi.org/10.1542/peds.2020-0702>
5. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet* 2020; **395**: 507–13. doi: [https://doi.org/10.1016/S0140-6736\(20\)30211-7](https://doi.org/10.1016/S0140-6736(20)30211-7)
6. Hong H, Wang Y, Chung H-T, Chen C-J. Clinical characteristics of novel coronavirus disease 2019 (COVID-19) in newborns, infants and children. *Pediatr Neonatol* 2020; **61**: 131–2. doi: <https://doi.org/10.1016/j.pedneo.2020.03.001>
7. Choi SH et al. Epidemiology and clinical features of coronavirus disease 2019 in children. *Clin Exp Pediatr* 2020;.
8. Chen A et al. Differences in clinical and imaging presentation of pediatric patients with COVID-19 in comparison with adults. *Radiology: Cardiothoracic Imaging* 2020; **2**: e200117.
9. Aminian A, Safari S, Razeghian-Jahromi A, Ghorbani M, Delaney CP. COVID-19 Outbreak and Surgical Practice: Unexpected Fatality in Perioperative Period. *Ann Surg* 2020; **272**: e27–e29. doi: <https://doi.org/10.1097/SLA.0000000000003925>
10. Cai Yet al. COVID-19 in the perioperative period of lung resection: a brief report from a single thoracic surgery department in Wuhan, China. *J Thorac Oncol* 2020;.
11. Yang S, Zhang Y, Cai J, Wang Z. Clinical Characteristics of COVID-19 After Gynecologic Oncology Surgery in Three Women: A Retrospective Review of Medical Records. *Oncologist* 2020; **25**: e982–e985. doi: <https://doi.org/10.1634/theoncologist.2020-0157>
12. Zhou C, Gao C, Xie Y, Xu M. COVID-19 with spontaneous pneumomediastinum. *Lancet Infect Dis* 2020; **20**: : 510p.. doi: [https://doi.org/10.1016/S1473-3099\(20\)30156-0](https://doi.org/10.1016/S1473-3099(20)30156-0)
13. Sun R, Liu H, Wang X. Mediastinal Emphysema, Giant Bulla, and Pneumothorax Developed during the Course of COVID-19 Pneumonia. *Korean J Radiol* 2020; **21**: 541. doi: <https://doi.org/10.3348/kjr.2020.0180>