Persistent Pneumonic Consolidations due to Secondary Organizing Pneumonia in a Patient Recovering from COVID-19 Pneumonia: A Case Report and Literature Review

Kyung-Wook Hong 1, Jung Wook Yang 2, Jong Duk Kim 3, Sunmi Ju 4, Min-Chul Cho 5, and In-Gyu Bae 1

1Division of Infectious Diseases, Department of Internal Medicine, Gyeongsang National University Hospital, Gyeongsang National University College of Medicine, Jinju, Korea
2Department of Pathology, Gyeongsang National University Hospital, Gyeongsang National University College of Medicine, Jinju, Korea
3Department of Cardiothoracic Surgery, Gyeongsang National University Hospital, Gyeongsang National University College of Medicine, Jinju, Korea
4Division of Pulmonology and Allergy, Department of Internal Medicine, Gyeongsang National University Hospital, Gyeongsang National University College of Medicine, Jinju, Korea
5Department of Laboratory Medicine, Gyeongsang National University Hospital, Gyeongsang National University College of Medicine, Jinju, Korea

ABSTRACT

In patients recovering from coronavirus disease 2019 (COVID-19) pneumonia, respiratory symptoms and radiographic pneumonic infiltrate occasionally persist for many weeks even after viral clearance; thereby, making it difficult to decide on an appropriate treatment. Here, we describe a 46-year-old woman with COVID-19 pneumonia who had persistent radiographic pneumonic infiltration and respiratory symptoms for almost 4 weeks after illness onset, despite viral clearance, and was subsequently diagnosed with secondary organizing pneumonia (SOP) using video-assisted thoracoscopic (VATS) wedge lung biopsy. Intravenous methylprednisolone was administered at an initial dose of 50 mg/day (1 mg/kg) for 7 days and was tapered to a dose of prednisolone 30 mg/day following improvement in the patient’s respiratory symptoms and chest radiographic findings. The patient was discharged from the hospital 14 days after the initiation of corticosteroid treatment. The dose of prednisolone was tapered monthly to 20, 15, 10, and 5 mg/day, respectively, at the outpatient clinic for a total duration of 6 months; nearly resolved pneumonic infiltrations were observed in a follow-up computed tomography scan approximately 2 months after she was admitted. To the best of our knowledge, this is the first case report of a COVID-19 associated SOP that was pathologically confirmed through VATS wedge lung biopsy in Korea. SOP should be considered in the differential diagnosis of patients with COVID-19 pneumonia with persistent respiratory symptoms and radiographic pneumonic infiltrations during the recovery phase to avoid the redundant use of antimicrobial or antiviral agents. Furthermore, histological confirmation is essential for the definitive diagnosis of SOP to avoid unnecessarily prolonged corticosteroid treatment.

Keywords: COVID-19; Secondary organizing pneumonia; Video-assisted thoracoscopic wedge lung biopsy
BACKGROUND

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and first identified in Wuhan, China in December 2019, poses a great threat to global public health. As the global pandemic continues, the number of patients who had recovered from COVID-19 and suffer from persistent symptoms with so called ‘long COVID-19’ or ‘post-acute COVID-19 syndrome’, also continues to grow [1]. Although the clinical manifestations and treatment strategies for acute COVID-19 had been studied since the beginning of the pandemic, the clinical features of the convalescent phase of COVID-19 are still not well-understood.

Radiological features in patients with COVID-19 pneumonia include bilateral ground-glass opacification (GGO), consolidation, and multi-lobar involvement with the predominantly peripheral or posterior distribution. Pan et al. [2] reported that the most severe chest computed tomography (CT) findings were visible on Day 10 after symptom onset, and improvements in imaging findings were observed in 75% of patients after Day 14.

Here, we report a patient with COVID-19 who had persistent radiographic pneumonic infiltration and respiratory symptoms until almost 4 weeks after illness onset, despite repeated negative results for SARS-CoV-2 RNA, no fever, and a normal C-reactive protein level (CRP); thereby, making it difficult to decide appropriate treatment. Our patient was diagnosed with secondary organizing pneumonia (SOP) through video-assisted thoracoscopic (VATS) wedge lung biopsy, which has an important implication in the treatment strategy for COVID-19-convalescent patients with persistent respiratory symptoms and radiological abnormalities even after viral clearance.

CASE REPORT

A 46-year-old woman confirmed with COVID-19, 1 week ago (February 28, 2020), was transferred to our hospital because of dyspnea on exertion, aggravation of pneumonic infiltration, and hypoxia. She had a history of hypertension and stated that the cough, her first COVID-19 symptom, began 11 days ago. Her physical examination revealed a body temperature, 36.5°C; blood pressure, 140/90 mmHg; pulse, 95 beats/min; respiratory rate, 22 breaths/min, and oxygen saturation, 88.0% on room air. The oxygen saturation increased to 95% with supplemental oxygen of 5 L/min, delivered via a nasal cannula. Chest high-resolution CT (HRCT) revealed peripheral dominant multifocal consolidation and GGO in both the lungs (Fig. 1A). A nasopharyngeal swab specimen was tested for respiratory viral pathogens using a nucleic acid amplification test on hospital Day 2 and was positive for parainfluenza virus 3 (Cycle threshold [Ct] value of 25.94 [range, >27 Ct]). The sputum culture had no bacterial growth. Laboratory test results on admission (illness Day 12) revealed CRP level, 16.6 mg/L (range, 0 - 5 mg/L); erythrocyte sedimentation rate (ESR), 120 mm/h (range, 0 - 20 mm/h); lactate dehydrogenase level, 288 IU/L (range, 135 - 225 IU/L), and D-dimer level, 3.09 µg/mL (range, 0 - 0.5 µg/mL) (Supplementary Table 1).

Figure 1. Chest high-resolution computed tomography (HRCT) (A) Chest HRCT on admission (Illness Day 12) shows peripheral dominant multifocal consolidation and ground-glass opacities (GGOs) in both the lungs. (B) There are no significant changes in bilateral multifocal consolidation and GGO on hospital day 15 (Illness day 26) or (C) hospital Day 22 (Illness day 33). (D) Follow-up HRCT on hospital day 35 (I illness day 46) after 12 days of steroid treatment shows slight improvements in multifocal consolidation and GGO in both the lungs. (E) At the 2-month follow-up from admission, HRCT shows further gradual improvements.
After admission, the patient was administered lopinavir and ritonavir (LPV/r) (400/100 mg twice daily) for 14 days and intravenous nafamostat mesylate (0.1 mg/kg/h) for 7 days. Ceftriaxone (2 g/day) was administered for 10 days owing to the potential of developing combined bacterial pneumonia. On days 1 - 19 of hospitalization (illness days 12 - 30), her vital signs remained stable with no fever, and she did not require oxygen supplementation after hospital Day 12. On hospital Day 15 (illness day 26), a follow-up HRCT was performed because she reported pleuritic chest pain and dyspnea on exertion with an ongoing cough. Chest radiography revealed slightly increased consolidation in both lungs. HRCT revealed no improvement in the multifocal peripheral dominant consolidations and GGO in either lung, despite 3 consecutive negative real-time reverse transcription-polymerase chain reaction (rRT-PCR) results for SARS-CoV-2 RNA (Fig. 1B). Treatment with hydroxychloroquine (400 mg/day) was initiated, and bronchoalveolar lavage (BAL) was performed to evaluate other potential causes of persistent respiratory symptoms and radiographic infiltrates. BAL fluid analysis results were as follows: white blood cell, 300/mm³; polymorphonuclear leukocytes, 4.0%; lymphocytes, 21.0%; eosinophils, 0.0%; and monocytes and macrophages, 75.0%. The respiratory virus and bacterial PCR multiplex panels, and bacterial culture obtained from the BAL fluid revealed no other respiratory pathogens.

On hospital day 19 (illness day 30), the patient underwent VATS wedge lung biopsy of the right upper lung lobe. Microscopic examination revealed intra-alveolar organizing fibroblastic tissues and lymphoplasmacytic infiltration, consistent with organizing pneumonia (OP) (Fig. 2A). Additionally, an interstitial organization in the peribronchiolar area and peribronchiolar metaplasia was present (Fig. 2B). Gomori methenamine silver and Periodic Acid-Schiff staining did not reveal any other microorganism. SARS-CoV-2 RNA was not detected in lung tissue using rRT-PCR. The patient was thus diagnosed with SOP associated with COVID-19 pneumonia. Intravenous methylprednisolone was administered at an initial dose of 50 mg/day (1 mg/kg) for 7 days and was tapered to a dose of 30 mg of daily prednisolone following improvements in respiratory symptoms and chest radiography (Supplementary Table 2). The patient was discharged on hospital day 37 (illness day 48) with a prescription for continued oral prednisolone (30 mg/day). The dose of prednisolone was gradually reduced monthly to 20, 15, 10, and 5 mg/day, respectively, at the outpatient clinic. Two months after admission to the hospital, a follow-up HRCT scan showed further improvements in the consolidations and GGO (Fig. 1E). The total duration of corticosteroid therapy was 6 months.

**DISCUSSION**

We reported a case of SOP that developed during the convalescent period of COVID-19. OP is a rare form of interstitial lung disease with a typical histopathological pattern of lung injury and characterized by the presence of fibroblasts and myofibroblasts forming intra-alveolar buds of granulation tissue with interstitial collagen deposition. SOP can be caused by various viral infections such as adenovirus, cytomegalovirus, herpes, human immunodeficiency virus, influenza, and Middle East respiratory syndrome coronavirus perhaps via immune system stimulation by viral antigens [3]. In a study of SARS, which has a 79.0% genome sequence homology with SARS-CoV-2, Wong et al. [4] reported that the proportion of patients with GGO and reticulation remained unchanged at 3 and 6 months after disease onset. An analysis of the pathological changes in SARS indicated that specimens collected on illness days 29 - 46 were characterized by organizing diffuse alveolar damage.
and fibrosis [5]. In a prospective observational study, persistent OP-like pattern in CT imaging with physiological and functional impairment was demonstrated at 6 weeks after discharge from the hospital in 4.2% (35/837) of the patients who had recovered from COVID-19, with subsequent symptomatic and radiological improvement after corticosteroid treatment [6]. We identified 25 COVID-19 related SOP cases reported in the literature and summarized 16 cases in Table 1 [7-15], excluding 9 cases diagnosed for SOP within illness Day 21 of COVID-19. The clinical presentations of SOP and dose and duration of corticosteroid treatment were heterogeneous. Males comprised 81.3% (13/16) of the cases, and 85.7% (12/14) patients had comorbidities. In 50.0% (8/16) cases, corticosteroids had been administered for acute COVID-19 treatment. Mean time point of SOP diagnosis was 37.8 illness days (range, 26 - 68) of COVID-19, and SOP was diagnosed based on the radiological findings and clinical improvements after corticosteroid treatment in approximately half of those cases. Regarding the clinical manifestations of SOP, 10 (62.5%) patients showed hypoxemia, and even respiratory failure was demonstrated in 3 patients. Most patients except 1 case were treated with corticosteroids for mean of 8.6 weeks (range, 4 - 20) of duration, with clinical improvements in all 16 cases. In our case, the patient had persistent radiographic pneumonic infiltration and respiratory symptoms for almost 4 weeks after illness onset despite viral clearance, which improved gradually after 6 months of corticosteroid treatment for SOP.

According to the U.S. Centers for Disease Control and Prevention’s guidance regarding ending isolation (updates as of August 31, 2022), extending the duration of isolation and precautions for severely ill COVID-19 patients is recommended, even up to 20 days after symptom onset and after resolution of fever with the improvement of symptoms. Moreover, residual respiratory symptoms and radiographic abnormalities due to SOP can be mistaken for unimproved or worsening COVID-19 pneumonia or combined bacterial pneumonia. Our finding that SOP can occur following COVID-19 pneumonia may explain why radiographic infiltrates and respiratory symptoms continue for an extended period after viral clearance and lengthy treatment [2]. In such situations, clinicians need to consider using anti-inflammatory agents such as corticosteroids, the mainstay of treatment for OP, and they should avoid inappropriate use of antibiotics or antiviral agents. Spontaneous remission of OP is rare, and a delay in treating the first episode is known to be a risk factor for relapse [3].

The National Institutes of Health guidelines recommended dexamethasone for COVID-19 treatment in hospitalized mechanically ventilated patients and in those who require supplemental oxygen based on the results from the RECOVERY trial [16]. However, corticosteroid was administered to our patient to treat the SOP that developed during the recovery stage with no requirement for supplemental oxygen, and not to treat severe COVID-19 pneumonia or acute respiratory distress syndrome. Moreover, the appropriate treatment strategies such as the optimal dosage, tapering schedule, and duration of corticosteroid therapy for COVID-19 associated SOP need to be further elucidated.

Our case illustrates the pathology of lung tissue during the COVID-19 recovery period when the patient had no fever, no need for supplemental oxygen, normal CRP level, decreasing ESR, and negative molecular test results for SARS-CoV-2 RNA, despite persistent radiographic pneumonic consolidations. The histopathological findings of our case revealed interstitial organization in the peribronchiolar area and peribronchiolar metaplasia besides the common findings of OP. The interstitial organization might have been a reparative change from lung injury caused by SARS-CoV-2 infection. Moreover, the peribronchiolar metaplasia that occurs because of chronic injury to the terminal airway, might be associated with SARS-CoV-2 infection, considering that the patient was a non-smoker with no history of prior chronic lung injury.

In our case, the respiratory virus PCR multiplex panel from the nasopharyngeal swab specimen on hospital Day 2 tested positive for parainfluenza virus 3, and the one from the BAL fluid on hospital Day 18 revealed no respiratory viruses. Certain viral coinfections may enhance the replication; thereby, affecting disease severity. It has been reported that cell fusion induced by parainfluenza virus 2 infection promoted influenza virus replication [17]. Although the possibility that the parainfluenza virus had also facilitated the occurrence of SOP in our case cannot be completely excluded, the likelihood is low considering the relatively low viral titer of parainfluenza virus 3 and the accumulation of literature regarding the radiological and clinical features of COVID-19 that is suggestive of OP pattern [4-6]. Notably, our case was treated with LPV/r, nafamostat mesylate, and hydroxychloroquine for COVID-19 pneumonia since remdesivir, recommended as a primary antiviral agent in the second half of 2020, was not available at the time when our case was admitted to the hospital (March 9, 2020).

We performed VATS wedge lung biopsy to obtain abundant lung tissue samples considering the relatively low sensitivity and negative predictive value of transbronchial biopsy for OP diagnosis [3]. To the best of our knowledge, although there has been a report of radiologically suspected COVID-19 related SOP in Korea, this is the first case report of COVID-19 associated SOP that was
| Age/Sex | Underlying diseases | Treatment for COVID-19 | Clinical manifestations of OP | Timing of OP diagnosis | Modality of diagnosis for OP | SARS-CoV-2 PCR results at the timing of OP diagnosis | Treatment for OP | Outcome | Reference/Country |
|---------|---------------------|------------------------|------------------------------|------------------------|-----------------------------|-----------------------------------------------|-----------------|---------|------------------|
| Pathologically confirmed cases |
| 46/F    | Hypertension        | LPV/r, HCQ, Nafamostat | Dyspnea                      | ID 30                  | VATS lung biopsy            | NP (Neg) BAL (Neg)                         | MPD, PD (24 weeks) | Improved | This case/Korea |
| 36/M    | Lymphoma            | None                   | Fever                        | ID 53                  | TBLB                        | NP (Neg) BAL (Pos)                         | Corticosteroid   | Improved | Golbets et al.[7]/Israel |
| 56/M    | None                | Dexamethasone, Favipiravir | Hypoxemia                    | ID 29                  | TBLB                        | BAL (Neg)                                   | PD (≥7 weeks)    | Improved | Kanaoka et al.[8]/Japan |
| 84/F    | Hypertension, Hypothyroidism, Dyslipidemia | Dexamethasone, Favipiravir | Dyspnea, Hypoxemia | ID 45                  | TBLB                        | BAL (Neg)                                   | PD (≥5 weeks)    | Improved |
| 71/M    | Hypertension, Diabetes, Dyslipidemia | LPV/r | Hypoxemia | ID 38                  | TBLB                        | NA                                           | MPD (4 weeks) | Improved | Klein et al.[9]/Argentina |
| 61/M    | Hypertension, Diabetes, Dyslipidemia | Dexamethasone | Fever, Malaise, Dyspnea | ID 38                  | TBLC | NP (Neg) | PD (20 weeks) | Improved | Nakakubo et al.[10]/Japan |
| 79/F    | Hypertension, Diabetes | Dexamethasone, Tollizumab, Remdesivir | Dyspnea, Fatigue | ID 45                  | TBLC | Saliva (Neg) | PD | Improved |
| 59/M    | Diabetes              | MPD, Remdesivir, Remdesivir | Fever, Fatigue, Dyspnea, Fever | ID 40                  | TBLC | Saliva (Neg) | NP (Neg) BAL (Pos) | PD | Improved | Pogatchnik et al.[11]/America |
| 61/F    | None                 | MPD, Remdesivir, Remdesivir | Fever, Fatigue, Dyspnea, Fever | ID 26                  | TBLB | TBLB | NA | Improved | Takumida et al.[12]/Japan |
| 70/M    | Hypertension, Dyslipidemia | MPD, Favipiravir | Hypoxemia | ID 34                  | TBLC | NP (Neg) BAL (Neg) Lung (Neg) | PD (4 weeks) | Improved | Vadász et al.[13]/Germany |
| 57/M    | NA                   | NA                        | Respiratory failure | ID 28                  | TBLB | TBLB | NA | Improved | Kostorz-Nosal et al.[14]/Poland |
| 70/M    | COPD                 | NA                        | Hypoxemia                   | ID 44                  | TBLB | TBLB | NA | Improved | Simões et al.[15]/Portugal |
| 76/M    | NA                   | NA                        | Hypoxemia                   | ID 68                  | TBLB | TBLB | NA | Improved |                      |
| Radiologically diagnosed cases |
| 67/M    | Hypertension, Diabetes | Dexamethasone | Respiratory failure | ID 28                  | Radiology | NA | MPD, PD (9 weeks) | Improved |
| 45/M    | Hypertension, Diabetes | LPV/r, HCQ | Dyspnea | ID 28                  | Radiology | NA | PD (8 weeks) | Improved |
| 71/M    | Hypertension, Diabetes | Dexamethasone | Respiratory failure | ID 30                  | Radiology | NP (Neg) | Corticosteroid (15 weeks) | Improved |
| 83/M    | Hypertension, Diabetes | LPV/r, HCQ | Hypoxemia | ID 30                  | Radiology | NP (Neg) | MPD (15 weeks) | Improved |

COVID-19, coronavirus disease 2019; OP, organizing pneumonia; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; PCR, polymerase chain reaction; LPV/r, lopinavir and ritonavir; HCQ, hydroxychloroquine; ID, illness day; VATS, video-assisted thoracoscopic; NP, nasopharyngeal; BAL, bronchoalveolar lavage; MPD, methylprednisolone; PD, prednisolone; TBLB, transbronchial lung biopsy; NA, not available; TBLC, transbronchial lung cryobiopsy; COPD, chronic obstructive pulmonary disease.
COVID-19 related secondary organizing pneumonia

pathologically confirmed through VATS lung biopsy [18]. Although performing VATS lung biopsy with risk of aerosol-generation was a concern of infection control around that time, when the duration of infectivity for SARS-CoV-2 has not been established, and the patient and her family hesitated to get an invasive operation, the patient, the thoracic surgeon, and the anesthesiologist understood and agreed to the absolute necessity of lung biopsy to determine a further treatment plan for persistent pneumonic consolidations and respiratory symptoms despite viral clearance. Due to its rarity and lack of familiarity, SOP is poorly recognized and misunderstood. Based on our findings, SOP should be considered in the differential diagnosis of COVID-19 convalescent patients showing persistent respiratory symptoms and radiographic pneumonic infiltrations for timely diagnosis and treatment initiation to prevent irreversible pulmonary fibrosis. Furthermore, the pathological examination should be considered for definitive diagnosis of SOP, for which administration of corticosteroids over several months with gradual tapering is required for remission and preventing relapses. The precise incidence of COVID-19 associated SOP needs to be clarified in a larger scale study, and accumulation of more scientific evidence to establish the most appropriate treatment strategies for SOP after COVID-19 is also required.

ACKNOWLEDGMENTS

We would like to thank CK Shim and HJ Lee of the Department of Internal Medicine, Gyeongsang National University Hospital, Jinju, Korea, for their valuable contributions to this article. We would like to thank Editage (www.editage.com) for English language editing.

ORCID iDs
Kyung-Wook Hong https://orcid.org/0000-0002-3227-9558
Jung Wook Yang https://orcid.org/0000-0002-9698-3667
Jong Duk Kim https://orcid.org/0000-0003-0268-1674
Sunmi Ju https://orcid.org/0000-0003-1474-1064
In-Gyu Bae https://orcid.org/0000-0002-9929-2271

Funding
None.

Ethics statement
This study was approved by the Gyeongsang National University Hospital Institutional Review Board (Approval No. 2020-04-009). The patient has provided written informed consent for the publication of this report and the accompanying images.

Conflict of Interest
No conflict of interest.

Author Contributions
Conceptualization: IGB, KWH. Data curation: KWH. Formal analysis: KWH. Methodology: KWH, JWY, JDK, SMJ, MCC. Supervision: JWY, JDK, SMJ, MCC, IGB. Writing-original draft: KWH. Writing-review & editing: KWH, JWY, JDK, SMJ, MCC, IGB.

SUPPLEMENTARY MATERIALS

Supplementary Table 1
The patient’s serial laboratory test results over the course of hospitalization: March 9 to April 13, 2020

Click here to view

Supplementary Table 2
Disease course by days of illness and days of hospitalization, March 9 to April 12, 2020

Click here to view

REFERENCES

1. Alkodaymi MS, Omrani OA, Fawzy NA, Shaar BA, Almamloulk R, Riaz M, Obeidat M, Obeidat Y, Gerberi D, Taha RM, Kashour Z, Kashour T, Berbari EF, Alkattan K, Tleyjeh IM. Prevalence of post-acute COVID-19 syndrome symptoms at different follow-up periods: a systematic review and meta-analysis. Clin Microbiol Infect 2022;28:657-66.
2. Pan F, Ye T, Sun P, Gui S, Lian B, Li L, Zheng D, Wang J, Hesketh RL, Yang L, Zheng C. Time course of lung changes at chest CT during recovery from coronavirus disease 2019 (COVID-19). Radiology 2020;295:715-21.
3. Drakopanagiotakis F, Polychronopoulos V, Judson MA. Organizing pneumonia. Am J Med Sci 2008;335:34-9.
4. Wong KT, Antonio GE, Hui DS, Ho C, Chan PN, Ng WH, Shing KK, Wu A, Lee N, Yip F, Joynt GM, Sung JJ, Ahuja AT. Severe acute respiratory syndrome: thin-section computed tomography features, temporal changes, and clinicroadiologic correlation during the convalescent period. J Comput Assist Tomogr 2004;28:790-5.
5. Cheung OY, Chan JW, Ng CK, Koo CK. The spectrum of pathological changes in severe acute respiratory syndrome (SARS). Histopathology 2004;45:119-24.
6. Myall KJ, Mukherjee B, Castanheira AM, Lam JI, Benedetti G, Mak SM, Preston R, Thillai M, Dewar A, Molyneaux PL, West AG. Persistent post-COVID-19 interstitial lung disease. An observational study of corticosteroid treatment. Ann Am Thorac Soc 2021;18:799-806.
COVID-19 related secondary organizing pneumonia

7. Golbets E, Kaplan A, Shafat T, Yagel Y, Jotkowitz A, Awesat J, Barski L. Secondary organizing pneumonia after recovery of mild COVID-19 infection. J Med Virol 2022;94:417-23. PUBMED | CROSSREF

8. Kanaoka K, Minami S, Ihara S, Tanaka T, Yasuoka H, Komuta K. Secondary organizing pneumonia after coronavirus disease 2019: Two cases. Respir Med Case Rep 2021;32:101356. PUBMED | CROSSREF

9. Klein F, Soriano JC, Anfuso MB, Ruiz V, Perazzo M, Paladini H, Vigliano A, Ossés J, Lowenstein P, Vigliano C, Caneva J. Transbronchial biopsies' histopathological findings leading to successful late steroid therapy in Covid-19 acute respiratory failure. Virchows Arch 2021;479:827-33. PUBMED | CROSSREF

10. Nakakubo S, Kamada K, Yamashita Y, Nakamura J, Matsumoto M, Hori H, Sato K, Morinaga D, Suzuki M, Okazaki N, Takakuwa E, Matsuno Y, Konno S. Delayed-onset organizing pneumonia emerging after recovery from coronavirus disease 2019: A report of three cases diagnosed using transbronchial cryobiopsy and a review of the literature. Intern Med 2022;61:1403-10. PUBMED | CROSSREF

11. Pogatchnik BP, Swenson KE, Sharifi H, Bedi H, Berry GJ, Guo HH. Radiology-pathology correlation demonstrating organizing pneumonia in a patient who recovered from COVID-19. Am J Respir Crit Care Med 2020;202:598-9. PUBMED | CROSSREF

12. Takumida H, Izumi S, Sakamoto K, Hashimoto M, Ishii S, Suzuki M, Takasaki J, Tanaka M, Igarı T, Hojo M. Sustained coronavirus disease 2019-related organizing pneumonia successfully treated with corticosteroid. Respir Investig 2021;59:377-81. PUBMED | CROSSREF

13. Vadász I, Husain-Syed F, Dorfmüller P, Roller FC, Tello K, Hecker M, Morty RE, Gattenlösner S, Walrath HD, Grimminger F, Herold S, Seeger W. Severe organising pneumonia following COVID-19. Thorax 2021;76:201-4. PUBMED | CROSSREF

14. Kostorz-Nosal S, Jastrzębski D, Chyra M, Kubicki P, Zieliński M, Ziora D. A prolonged steroid therapy may be beneficial in some patients after the COVID-19 pneumonia. Eur Clin Respir J 2021;8:1945186. PUBMED | CROSSREF

15. Simões JP, Alves Ferreira AR, Almeida PM, Trigueiros F, Braz A, Inácio JR, Medeiros FC, Braz S, Pais de Lacerda A. Organizing pneumonia and COVID-19: A report of two cases. Respir Med Case Rep 2021;32:101359. PUBMED | CROSSREF

16. RECOVERY Collaborative Group, Horby P, Lim WS, Emberson JR, Mafham M, Bell JL, Linsell L, Staplin N, Brightling C, Ustianowski A, Elmahi E, Prudon B, Green C, Felton T, Chadwick D, Rege K, Fegan C, Chappell LC, Faust SN, Jaki T, Jeffery K, Montgomery A, Rowan K, Juszczak E, Baillie JK, Haynes R, Landray MJ. Dexamethasone in hospitalized patients with Covid-19. N Engl J Med 2021;384:693-704. PUBMED | CROSSREF

17. Kumar N, Sharma S, Barua S, Tripathi BN, Rouse BT. Virological and immunological outcomes of coinfections. Clin Microbiol Rev 2018;31:e00111-17. PUBMED | CROSSREF

18. Seo H, Jung J, Kim MJ, Jang SJ, Kim SH. Radiologically suspected organizing pneumonia in a patient recovering from COVID-19: A case report. Infect Chemother 2022;54:208-12. PUBMED | CROSSREF