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Case Report

Multi-Organ Relapse following COVID-19 in Myeloperoxidase-Anti-Neutrophil Cytoplasmic Antibody-Associated Vasculitis: A Case Report

Won-Hee Cho[a] Seo Yeon Hwang[b] Sun Ryoung Choi[a] Biro Kim[a]
Joune Seoup Lee[c] Dong Gun Lee[d] Hyun Soon Lee[e]

[a]Division of Nephrology, Department of Internal Medicine, Sahmyook Medical Center, Seoul, Republic of Korea; [b]Department of Internal Medicine, Sahmyook Medical Center, Seoul, Republic of Korea; [c]Division of Gastroenterology, Department of Internal Medicine, Sahmyook Medical Center, Seoul, Republic of Korea; [d]Department of Neurology, Sahmyook Medical Center, Seoul, Republic of Korea; [e]Hankook Renal Pathology Lab., Seoul, Republic of Korea

Keywords
Anti-neutrophil cytoplasmic antibody vasculitis · COVID-19 · Multi-organ relapse · Dialysis · End-stage kidney disease

Abstract
Anti-neutrophil cytoplasmic antibody (ANCA)-associated vasculitis (AAV) is a complex systemic autoimmune disease characterized by small vessel vasculitis. Typically, the relapse rate is lower in patients with end-stage kidney disease (ESKD) than in those with chronic kidney disease, prior to dialysis. Here, we report a rare case of multi-organ relapse in a patient with myeloperoxidase (MPO)-AAV who underwent hemodialysis following coronavirus disease 2019 (COVID-19). A man in his 70s with type 2 diabetes and hypertension was undergoing maintenance hemodialysis for ESKD resulting from MPO-AAV glomerulonephritis. Following severe acute respiratory syndrome coronavirus 2 infection, the patient was hospitalized for persistent nausea and vomiting. No significant findings were observed, including in endoscopy. However, the patient experienced severe symptoms that hindered oral intake and was refractory to pharmacological therapy. Additionally, despite receiving antibiotics and antituberculosis treatment, the patient experienced persistent unexplained pleural effusion. Moreover, the patient's level of consciousness rapidly deteriorated during hospitalization. Although C-reactive protein levels and MPO-ANCA titers were elevated, no evidence of infection was detected on brain imaging or cerebrospinal fluid analysis. Therefore, we diagnosed this case as a relapse of AAV and promptly

Correspondence to:
Won-Hee Cho, minime12@naver.com

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administered methylprednisolone pulse therapy and rituximab. Subsequently, all aforementioned symptoms in the patient improved, and the current ANCA levels remain negative. Thus, the relapse of AAV after COVID-19 is rare; however, it can present in several ways in patients undergoing dialysis. Therefore, clinicians should closely monitor ANCA titers and subtle symptoms, even in patients with dialysis-dependent AAV.

Introduction

Anti-neutrophil cytoplasmic antibody (ANCA)-associated vasculitis (AAV) is a group of complex systemic autoimmune diseases characterized by inflammation of small blood vessels and the presence of specific circulating antigens, ANCA-targeting proteinase 3 (PR3) and myeloperoxidase (MPO). AAV commonly affects the kidneys, causing severe damage and requiring renal replacement therapy. When patients with AAV progress to end-stage kidney disease (ESKD), their relapse rate is notably lower than that observed in patients with chronic kidney disease, before dialysis [1]. The two potential reasons for this observation are as follows: (a) owing to its impaired function, the kidney is no longer susceptible to AAV relapse; (b) the impaired immune response due to kidney failure may lead to a potential reduction in disease activity, similar to that observed in systemic lupus erythematosus [2]. Moreover, coronavirus disease 2019 (COVID-19) reportedly induces or worsens autoimmune diseases, with some cases in the literature suggesting that it may trigger new onsets or flares of AAV [3]. Herein, we present an unusual case of multi-organ relapse in a patient with MPO-AAV who underwent maintenance hemodialysis following severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection. The CARE Checklist has been completed by the authors for this case report, attached as online supplementary material (for all online suppl. material, see https://doi.org/10.1159/000534331).

Case Presentation

A man in his 70s with type 2 diabetes and hypertension presented with rapidly deteriorating renal function, gross hematuria, and proteinuria. The patient was a nondrinker and an ex-smoker with a history of 30 pack-years. He worked as a concrete truck driver for over 30 years, with no significant family medical history. He was on medications including irbesartan, metformin, alogliptin, pioglitazone, and atorvastatin. Prior to admission, his serum creatinine level was 1.31 mg/dL, and urinalysis showed no abnormalities. However, on admission to our hospital, the serum creatinine level was elevated to 6.36 mg/dL, and urinalysis showed microscopic hematuria; moreover, the urinary protein to creatinine ratio was 8.93 g/g. An emergency renal biopsy revealed pauci-immune necrotizing crescentic glomerulonephritis (shown in Fig. 1).

The patient had an MPO-ANCA titer of 21.4 IU/mL (negative: <3.5), whereas all other serologic tests, including anti-PR3 antibodies, were negative. Moreover, there was no evidence of involvement of other organs, including the respiratory system. Therefore, a diagnosis of renal-limited AAV was established. The patient was administered methylprednisolone (MPD) pulse therapy at a dose of 500 mg for 3 consecutive days, followed by four doses of rituximab (375 mg/m^2), administered weekly. Additionally, oral prednisolone was initiated at 50 mg daily and tapered every 2 weeks. However, despite receiving immunosuppressants, the

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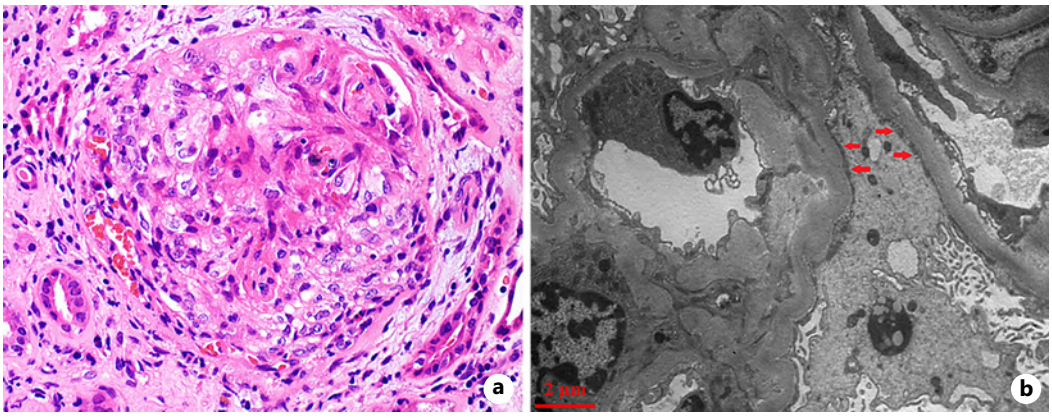

Fig. 1. Kidney biopsy findings. **a** Light microscopy displaying crescent formation in a glomerulus (periodic acid-Schiff; original magnification, ×400). **b** Ultrastructural examination using electron microscopy presenting diffusely effaced epithelial cell foot processes (red arrows).

disease progressed to ESKD. As stable hemodialysis was maintained for the patient without evidence of other organ involvement, rituximab maintenance therapy was discontinued, and prednisolone was gradually tapered and discontinued after 6 months of treatment.

Twelve months after initiating dialysis, the patient underwent total graft excision owing to infected prosthetic dialysis arteriovenous graft (AVG) caused by methicillin-resistant *Staphylococcus aureus*. The patient received four COVID-19 vaccinations prior to the AVG excision: the first and second doses of AstraZeneca ChAdOx1-S on June 10, 2021, and August 26, 2021, respectively. Subsequently, owing to extremely rare but concerning issues associated with the AstraZeneca vaccine, such as the risk of vaccine-induced immune thrombotic thrombocytopenia (VITT) or thrombosis with thrombocytopenia syndrome (TTS), the third dose administered was of Moderna mRNA-1273 on February 12, 2022. The fourth dose of Pfizer-BioNTech BNT162b2 was administered on March 29, 2022. However, 3 months after the AVG excision, the patient was hospitalized for SARS-CoV-2 infection. Characterization of SARS-CoV-2 variants was not performed in this patient. Given the prevailing variants in South Korea during that period, it was presumed that the patient was infected with the Omicron BA.5 subvariant. The patient was in a stable condition without the need for oxygen therapy and received remdesivir treatment (initial 200 mg dose, followed by a daily dose of 100 mg thereafter); however, glucocorticoid therapy was not administered. Owing to a CRP level >30 mg/dL and the inability to rule out potential bacterial pneumonia, piperacillin and tazobactam were coadministered at a dose of 2.25 g every 8 h for 7 days. The infection was successfully treated using a 5-day remdesivir regimen in conjunction with antibiotic therapy. Post-discharge, the patient complained of general weakness, myalgia, persistent nausea, and vomiting without any identifiable cause. Consequently, the patient was readmitted to the gastroenterology department 1 month later. The MPO-ANCA titer consistently increased, reaching 17.8 IU/mL on admission. Although the SARS-CoV-2 infection had been effectively treated, the blood C-reactive protein (CRP) level remained elevated at 15.1 mg/dL (shown in Fig. 2). Gastroscopy and colonoscopy findings were unremarkable, except for mild hemorrhagic gastritis and erosive duodenitis. Histology of the gastric antrum revealed only chronic superficial gastritis, with no evidence of vasculitis. However, the nausea and vomiting remained unresponsive to antiemetics, and the patient was unable to tolerate oral intake, thus requiring the initiation of parenteral nutrition. Furthermore, an asymptomatic right-dominant pleural effusion was discovered on the chest radiograph, and thoracentesis was performed subsequently. The chest computed tomography (CT) findings are illustrated in Figure 3; the

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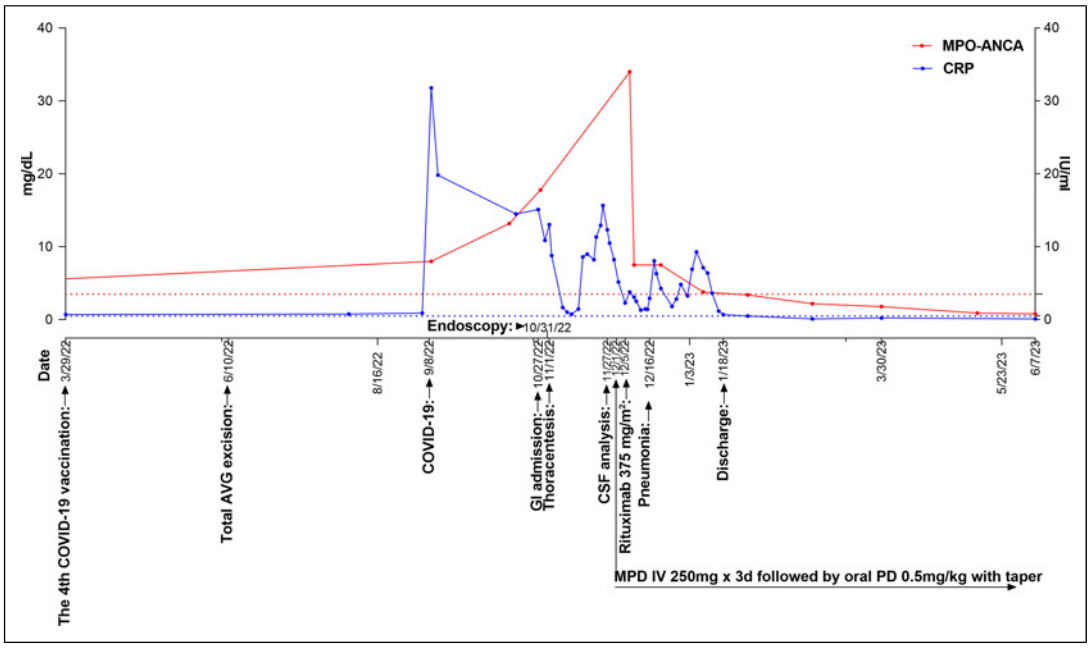

Fig. 2. Timeline of clinical events following COVID-19 to discharge and last follow-up. Red lines or dots indicate MPO-ANCA titers, and blue lines or dots indicate CRP levels. The red dotted horizontal line represents the equivocal threshold value 3.5 (<3.5: negative, 3.5–5.0: equivocal, >5.0: positive) for MPO-ANCA measured by fluorimetric enzyme-linked immunoassay (FEIA) at Samkwang Medical Laboratories. The blue dotted horizontal lines represent the reference value 0.5 (<0.5: negative). MPO, myeloperoxidase; AVG, arteriovenous graft; ANCA, anti-neutrophil cytoplasmic antibody; CRP, C-reactive protein; COVID-19, coronavirus disease 2019; GI, gastroenterology; CSF, cerebrospinal fluid; MPD, methylprednisolone; PD, prednisolone.

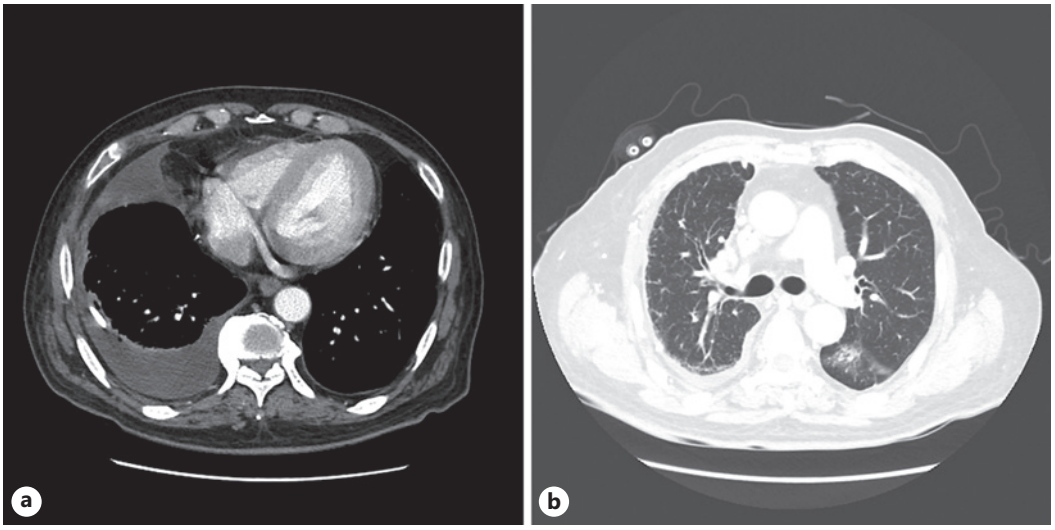

Fig. 3. Chest CT images from November 3rd, 2022. **a** Right pleural effusion; pigtail catheter inserted. **b** Irregular consolidation and ground-glass opacities in the superior segment of the left lower lobe.

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abdominal and pelvic CT showed no significant abnormalities. Pleural fluid analysis revealed a lymphocyte-predominant exudate with an elevated adenosine deaminase (ADA) level (62.8 U/L), with no evidence of bacterial infection or malignancy. The possibility of tuberculous (TB) pleurisy could not be excluded as a potential cause; therefore, anti-TB drugs consisting of isoniazid 300 mg daily, rifampin 600 mg daily, moxifloxacin 400 mg daily, and pyrazinamide 1,500 mg thrice weekly were administered. However, no significant reduction in the amount of pleural effusion was observed despite administration of antibiotics for over 2 weeks. Moreover, the interferon-γ release assay results were negative. Therefore, the anti-TB treatment was discontinued.

During hospitalization at the gastroenterology department, the blood CRP level, which had previously returned to normal levels, was elevated again. The ANCA titer continued to rise steadily, reaching a peak of 34 IU/mL (shown in Fig. 2). The initial symptoms of nausea and vomiting worsened progressively. Furthermore, despite adequate control of dry weight with hemodialysis, refractory hypertension with systolic blood pressure above 180 mm Hg and repeated headaches persisted. One month after hospitalization, the patient had no fever; however, he presented with a progressive decline in consciousness as CRP levels increased to 15.7 mg/dL (see Table 1). The cerebrospinal fluid (CSF) was investigated for signs of meningitis; the CSF protein levels were 57.60 mg/dL (reference range, 15–45 mg/dL) with no specific findings indicating infection. Moreover, no abnormalities were detected on the brain magnetic resonance imaging (MRI) scan and electroencephalograph. Based on these findings, we determined that the symptoms of the patient were likely owing to the systemic manifestations of relapsing ANCA vasculitis. At the time, the Birmingham Vasculitis Activity Score (BVAS) was 8 for the Persistent Score and 17 for the New/Worse Score (Table 2) [4]. Therefore, the patient was transferred to the nephrology department and promptly initiated with immunosuppressive therapy.

After 3 consecutive days of MPD (250 mg) administration, the patient's consciousness improved, accompanied by relief from nausea and vomiting. Given the advanced age and frailty of the patient, we considered additional treatment with rituximab (375 mg/m^2) at 2-week intervals. Following treatment with MPD and a single rituximab therapy, the MPO-ANCA titer and CRP level decreased to 7.5 IU/mL and 1.32 mg/dL, respectively. Oral prednisolone was initiated at a daily dose of 40 mg and gradually tapered, as illustrated in Figure 2. However, 10 days after the first dose of rituximab, the patient developed pneumonia caused by an extended-spectrum beta-lactamase (ESBL)-positive *Klebsiella pneumoniae* infection, which was treated with ertapenem 500 mg daily for 2 weeks, and rituximab treatment was discontinued. Seven weeks later, the MPO-ANCA titer was negative, and all clinical symptoms improved, resulting in a New/Worse BVAS score of 0. Consequently, the patient was discharged and is currently stable, undergoing maintenance hemodialysis without the need for additional immunosuppressants. The key features of the clinical case are presented in Figure 2.

Discussion

When patients with AAV progress to ESKD, vasculitis relapse is rare. However, SARS-CoV-2 infection can potentially trigger autoimmune diseases, including AAV [3]. We present an exceptional case of vasculitis relapse involving multiple organs, initially involving the gastrointestinal (GI) system and subsequently progressing to the pulmonary system. Eventually, the condition advanced to central nervous system (CNS) involvement.

Serious respiratory complications, including diffuse alveolar hemorrhage, are of particular concern in individuals with ESKD. However, this case emphasizes that COVID-19 can lead to atypical multisystem involvement, even in patients with initially renal-limited AAV.

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Table 1. Laboratory data on admission

Parameter	Result	Reference range	Parameter	Result	Reference range
Complete blood count			*Miscellaneous*		
White blood cells, $\times 10^3/\mu L$	9.61	4.6–10.2	Myeloperoxidase (*p*-ANCA, IU/mL)	Positive (34.0)	0–1.0
Neutrophils, %	60.4	43–75	Proteinase 3 (c-ANCA, IU/mL)	Negative (<0.6)	0–1.0
Lymphocytes, %	21.2	10–50	Antinuclear antibody	Positive; 1:80	Negative
Monocytes, %	12.4	0–12	Anti-GBM antibody, U/mL	Negative	Negative
Eosinophils, %	5.5	0–7	C3, mg/dL	97	90–180
Basophils, %	0.5	0–2.5	C4, mg/dL	42	10–40
Hemoglobin, g/dL	8.7	13–18.1	CH50, IU/mL	62.4	23–46
Hematocrit, %	25.4	38–53.7	*Pleural fluid analysis*		
Platelet count, $\times 10^3/\mu L$	121	130–400	Color	Bloody	
Complete metabolic panel			pH	7.5	
C-reactive protein, kg/dL	15.7	<0.5	Specific gravity	1.015	
Erythrocyte sedimentation rate, mm/h	120	0–10	RBC, $/mm^3$	52,000	
Total protein, g/dL	6.6	6.0–8.3	WBC, $/mm^3$	1,390	
Albumin, g/dL	3.2	3.3–5.2	Neutrophils, %	7	
Total bilirubin, mg/dL	0.6	<1.2	Lymphocytes, %	42	
Aspartate aminotransferase, IU/L	22	9–38	Monocytes, %	2	
Alanine aminotransferase, IU/L	4	9–41	Eosinophils, %	21	
Lactate dehydrogenase, IU/L	203	135–225	Histiocyte, %	28	
Creatinine phosphokinase, IU/L	241	0–172	Adenosine deaminase	62.8	
Blood urea nitrogen, mg/dL	49.4	4–23	Protein, g/dL	5.22	
Creatinine, mg/dL	8.78	0.1–1.2	Glucose, mg/dL	92	
Sodium, mEq/L	131	135–150	Lactate dehydrogenase, IU/L	229	
Potassium, mEq/L	5.2	3.5–5.5	Albumin, g/dL	2.66	
Chloride, mEq/L	90	95–110	Triglyceride, mg/dL	32.3	
Calcium, mg/dL	9.9	8.6–10.2	Carcinoembryonic antigen, ng/mL	1.3	
Total CO_2, nmol/L	19	22–29	*Cerebrospinal fluid analysis*		
Phosphate, mg/dL	5.9	2.5–4.5	Color	Color less	
Magnesium, mg/dL	2.5	1.9–2.5	pH	8.5	
Total cholesterol, mg/dL	170	<200	Specific gravity	1.015	
Triglyceride, mg/dL	106	10–180	RBC, $/mm^3$	0	

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Table 1 (continued)

Parameter	Result	Reference range	Parameter	Result	Reference range
HDL-cholesterol, mg/dL	42	35–70	WBC, /mm^3	0	
LDL-cholesterol, mg/dL	107	0–129	Neutrophils, %	0	
Ferritin, ng/mL	509	30–400	Lymphocytes, %	0	
Transferrin saturation, %	42.01	20–50	Monocytes, %	0	
Intact parathyroid hormone, pg/mL	23.1	15.0–65.0	Eosinophils, %	0	
Glucose, mg/dL	138	70–110	Basophils, %	0	
Prothrombin time (INR)	1.1	0.8–1.3	Histiocyte, %	0	
Urinalysis			Mesothelial cell, %	0	
Urine protein to creatinine ratio, g/g	2.55		Macrophage, %	0	
Occult blood	3+	Negative	Malignant cell, %	0	
Glucose	2+	Negative	Other cell, %	0	
Red blood cells (/HPF)	>50	0–2	Protein, mg/dL	57.6	15–45
White blood cells (/HPF)	6–10	0–2	Glucose, mg/dL	85	40–80

MPO, myeloperoxidase; ANCA, anti-neutrophil cytoplasmic antibodies; GBM, glomerular basement membrane; CH50, complement hemolysis 50.

Although a causal relationship between COVID-19 and AAV relapse cannot be established, the close temporal proximity between COVID-19 and symptom onset, along with elevated MPO-ANCA titers and CRP levels, suggests a possible association.

Considering the intricate and nonspecific nature of AAV, a comprehensive assessment of organ involvement requires the integration of clinical presentation, imaging modalities, laboratory tests, and occasionally histopathological findings. In our case, newly developed clinical findings provided insights into organs potentially affected during relapse. Treatment-resistant nausea and vomiting occurring without apparent provocation suggested GI involvement of AAV. GI manifestations of AAV can vary from mild abdominal pain to life-threatening complications, such as peritonitis and GI bleeding. Among these manifestations, nausea and vomiting are the commonly noted symptoms [5]. Therefore, an endoscopic examination was performed to evaluate the GI tract. Nonetheless, diagnosis of GI vasculitis can be challenging owing to the low sensitivity of endoscopic biopsies and the variety of endoscopic findings [6]. Gastritis and duodenitis were observed in our patient, which are not characteristic of AAV and are commonly observed in the general population as nonspecific manifestations. However, endoscopic procedures assisted in excluding other potential causes, thereby strengthening the association with AAV.

Furthermore, through imaging evaluations including chest radiograph and thoracoabdominal CT scan, potential abnormalities in organs were assessed, confirming the presence of pleural effusion. Subsequent thoracentesis confirmed a lymphocyte-dominated exudate, suggesting AAV-induced pleural effusion, following the exclusion of other alternative etiologies such as infectious diseases or malignancies.

Diagnostic evaluations for symptoms of headache and altered consciousness included brain MRI, electroencephalograph, and CSF analysis. After excluding infections, malignancies, or other disorders, a presumptive diagnosis of CNS-AAV was reached. CNS-AAV diagnosis can also be challenging as brain MRI and CSF analysis may reveal nonspecific abnormalities [7]. Moreover, a normal brain MRI does not rule out CNS involvement in AAV [8].

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Table 2. BVAS record calculated at remission prior to induction treatment in our case

BVAS items (by organ system)	New/ Worse	Persistent	BVAS items (by organ system)	New/ Worse	Persistent
1. General			*6. Cardiovascular*		
Myalgia	1		Loss of pulses		
Arthralgia/arthritis			Valvular heart disease		
Fever (≥38.5 degree Celsius)			Pericarditis		
Weight loss (≥2 kg)	2		Ischemic cardiac pain		
2. Cutaneous			Cardiomyopathy		
Infarct			Congestive heart failure		3
Purpura			*7. Abdominal*		
Ulcer			Peritonitis		
Gangrene			Bloody diarrhea		
Other skin vasculitis			Severe abdominal pain		
3. Mucous membranes/eyes			*8. Renal*		
Mouth ulcers/granulomata			Hypertension	4	
Genital ulcers			Proteinuria >1+		2
Adnexal inflammation			Hematuria ≥10 RBCs/HPF		3
Significant proptosis			Serum creatinine 125–249 μmol/L		
Scleritis/episcleritis			Serum creatinine 250–499 μmol/L		
Conjunctivitis/blepharitis/ keratitis			Serum creatinine ≥500 μmol/L		
Blurred vision			Rise in serum creatinine >30% or fall in creatinine clearance >25%		
Sudden vision loss			*9. Nervous system*		
Uveitis			Headache	1	
Retinal changes (vasculitis/ thrombosis/exudate/ hemorrhage)			Meningitis		
4. Ear, nose, and throat			Organic confusion	3	
Bloody nasal discharge/ crusts/ulcers/granulomata			Seizures (not hypertensive)		
Paranasal sinus involvement			Cerebrovascular accident		
Subglottic stenosis			Spinal cord lesion		
Conductive hearing loss			Cranial nerve palsy		
Sensorineural hearing loss			Sensory peripheral neuropathy		
5. Chest			Mononeuritis multiplex		
Wheeze					
Nodules or cavities					

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Table 2 (continued)

BVAS items (by organ system)	New/ Worse	Persistent	BVAS items (by organ system)	New/ Worse	Persistent
Pleural effusion/pleurisy	4				
Infiltrate	2				
Endobronchial involvement					
Massive hemoptysis/ alveolar hemorrhage					
Respiratory failure					

BVAS for the Persistent Score = 8 points with 3 for congestive heart failure, 2 for proteinuria, 3 for hematuria. BVAS for the New/Worse Score = 17 points with 1 for myalgia, 2 for weight loss, 4 for pleural effusion, 2 for chest infiltrate, 4 for hypertension, 1 for headache, 3 points for organic confusion.

BVAS, Birmingham Vasculitis Activity Score.

In the laboratory findings, ANCA titer elevation could be associated with relapse in MPO-AAV patients with renal involvement [9]. Elevated CRP levels, in the absence of infection, indicate systemic inflammation and persistent autoimmune activity. Moreover, the effectiveness of immunosuppressants in reducing ANCA titer and resolving clinical symptoms provides compelling evidence of AAV relapse. Notably, the fact that the patient remained stable, without the need for immunosuppression, and maintained negative MPO-ANCA status for over 6 months, following a single dose of rituximab, indirectly implies that AAV recurrence may have been triggered by COVID-19.

Based on autopsies of COVID-19 patients, SARS-CoV-2 infection displays extensive effects across multiple systems, characterized by hypercoagulability, hyperinflammation, and endothelial dysfunction [8]. The potential mechanism by which SARS-CoV-2 infection may contribute to the development of AAV is as follows.

SARS-CoV-2 infection occurs through its high-affinity binding to the angiotensin-converting enzyme 2 receptor, allowing the virus to invade endothelial cells. Subsequently, this intrusion induces neutrophil priming, elevating the surface expression of ANCA antigens. Consequently, ANCA binds to PR3/MPO on neutrophils, triggering their activation and ultimately leading to the formation of neutrophil extracellular traps (NETs) [10]. NETs are net-like structures composed of DNA-histone complexes and proinflammatory mediators released by activated neutrophils, which can serve as a source of self-antigens such as MPO or PR3. Ultimately, NETs promote the generation of ANCAs, contributing to the development of AAV through endothelial damage and complement activation [11]. Notably, patients with AAV exhibit elevated levels of circulating NETs, which have also been observed in their kidney tissue [12].

Additionally, in our patient, *S. aureus*-induced AVG infection may have served as a potential precipitating factor for the AAV flare-up. Plasmid-encoded 6-phosphogluconate dehydrogenase sequence in certain strains of *S. aureus* can potentially trigger MPO-AAV through molecular mimicry [13].

The coexistence of COVID-19 and AAV in patients could be coincidental, yet similar prior cases suggest a potential association. A review of the literature identified 27 cases linking COVID-19 and AAV. Among these, 9 patients showed concurrent COVID-19 and AAV onset, while the remaining 18 had 2-week to 6-month interval between the two (see online suppl. Table 1). Of the 27 patients, 2 PR3-AAV patients with alveolar hemorrhage did not survive. However, the remaining 25 responded well to immunosuppressive therapy. Similarly, our patient improved with MPD pulse therapy and single dose of rituximab treatment.

Following recovery from COVID-19, MPO-AAV and PR3-AAV occurred in 17 and 10 patients, respectively, with average ages of 55.8 and 44.5 years. Notably, 6 patients, five with MPO-AAV and 1 with PR3-AAV, developed ESKD. Moreover, 23 patients without underlying autoimmune disease developed AAV, suggesting that COVID-19 alone may trigger AAV. Conversely, all 4 patients with preexisting autoimmune disease developed MPO-AAV after COVID-19. However, drawing definitive conclusions is challenging due to the limited cases. Therefore, further research using a larger cohort is required to confirm whether COVID-19 preferentially induces MPO-AAV over PR3-AAV in patients with autoimmune disease.

Our patient had no distinct adverse events subsequent to COVID-19 vaccination, including thrombotic events. Thus, any correlation between the vaccination and the AAV relapse remains unsubstantiated. VITT or TTS represents an exceedingly rare complication, predominantly noted following the administration of adenoviral vector-based COVID-19 vaccines, such as ChadOx1 nCOV-19 (AstraZeneca COVID-19 vaccine) and Ad26. COV2.S (Janssen vaccine). It is characterized by thrombocytopenia and venous or arterial thrombosis in unusual locations, such as cerebral venous sinuses or intestinal vessels [14]. The pathophysiology of VITT or TTS originates from vaccine-induced IgG antibodies that recognize platelet-factor 4 (PF4) bound to platelets, leading to platelet activation. Additionally, these anti-PF4 antibodies not only activate the coagulation cascade but also activate monocytes, neutrophils, and endothelial cells, ultimately leading to thrombosis [15].

A limitation of this case was that the diagnosis of relapsing AAV relied on an exclusion diagnosis without histopathological confirmation. A second renal biopsy was not performed owing to the preexisting ESKD state in the patient and because the gastric biopsy did not reveal evidence of vasculitis. However, given that AAV can present with nonspecific symptoms, such as generalized weakness, anorexia, and weight loss with elevated CRP levels, it is crucial to exclude acute infectious and malignant etiologies prior to diagnosing AAV.

In conclusion, COVID-19 can lead to indistinct relapse of systemic vasculitis in patients with dialysis-dependent AAV. Therefore, in cases where ANCA titers remain persistently elevated or reappear, clinicians should be vigilant regarding atypical symptoms, consider multiple differential diagnoses, and actively monitor ANCA levels for prompt detection and treatment of vasculitis relapse.

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Statement of Ethics

This study was reviewed and received exempt approval by the Institutional Review Board (IRB) of Sahmyook Medical Center, Seoul, IRB number 116286-202304-HR-01. Written informed consent was obtained from the patient for publication of the details of this case report and any accompanying images.

Conflict of Interest Statement

The results presented in this paper have not been published previously, either in their entirety or in part. The authors have no conflicts of interest to declare.

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Author Contributions

W.H. collected clinical information, drafted the manuscript, and was responsible for the critical revision of the manuscript for important intellectual content. S.Y., S.R., Biro, J.S., D.G., and H.S. supported the data collection and helped draft the manuscript. All authors participated in revising the draft manuscript and approving the final manuscript.

Data Availability Statement

All data generated or analyzed during this study are included in this article and its online supplementary material. Further inquiries can be directed to the corresponding author.

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