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Eye Involvement in COVID-19 - A Narrative Review

Katarzyna Cencelewicz (KC)

ORCID 0009-0000-5318-4606

E-mail k.cencelewicz123@gmail.com

1st Military Clinical Hospital with the Polyclinic, Lublin, Poland

Patrycja Bździuch (PB)

ORCID 0009-0007-6830-0287

E-mail patrycja.bzdziuch@op.pl

John Paul II Western Hospital, Grodzisk Mazowiecki, Poland

Jakub Buziak (JB)

ORCID 0009-0004-5833-975X

E-mail Kbuziak11@gmail.com

Franciszek Raszeja Municipal Hospital, Poznań, Poland

Paulina Miciuda (PM)

ORCID 0009-0006-0719-5260

E-mail paulina.miciuda1@gmail.com

Hospital of the Order of the Bonifraters of St. Jan Grande, Kraków, Poland

Aleksandra Grzywacz-Guza (AGG)

ORCID 0009-0009- 2552-4699

E-mail olaa.grzywacz@gmail.com

1st Military Clinical Hospital with the Polyclinic, Lublin, Poland

Patrycja Hatala (PH)

ORCID 0000-0002-9934-8618

E-mail patrycjahatala@gmail.com

The Provincial Hospital in Bielsko-Biała, Bielsko-Biała, Poland

Marek Kochański (MK)

ORCID 0009-0008-0304-8938

E-mail mkochanski304@gmail.com

1st Military Clinical Hospital with the Polyclinic, Lublin, Poland

Corresponding Author

Katarzyna Cencelewicz, E-mail k.cencelewicz123@gmail.com

Abstract

Background. The COVID-19 pandemic has led to a global health crisis with a wide spectrum of systemic complications. While incidence and mortality rates are gradually declining, increasing attention is being paid to the long-term effects of COVID-19 including ocular manifestations.

Aim. This narrative review summarizes the current evidence on ophthalmic findings associated with COVID-19, including their clinical presentation, pathophysiology, and potential long-term consequences.

Material and methods. A literature search was conducted in February 2026 using the terms: (COVID-19 OR SARS-CoV-2) AND (ocular OR ophthalmic OR eye) AND (complications OR manifestations). English-language studies published since January 2020 were included. Studies were selected based on title and abstract screening and full-text review.

Results. COVID-19 is associated with a wide range of ophthalmic manifestations and complications. Among the most frequently described in the literature are acute macular neuroretinopathy (AMN), acute angle closure (AAC), uveitis, and mucormycosis. AMN has been linked to microvascular disturbances following infection. AAC may present with a more severe course, likely influenced by both physiological and behavioral factors. Uveitis may occur de novo or as reactivation of pre-existing disease, with autoimmune mechanisms suggested. An increased incidence of mucormycosis has been observed, particularly in patients treated with corticosteroids and those with diabetes.

Conclusions. Ophthalmic complications of COVID-19 are heterogeneous and may result from vascular, immune, and infectious mechanisms. Further research is needed to clarify long-term ocular consequences and optimize patient care.

Key words: COVID-19; SARS-CoV-2; eye; ophthalmic manifestations; ophthalmic complications

1. Introduction

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), led to a global pandemic with far-reaching consequences. It was one of the major public health crises of the 21st century. Patients presented with a wide range of clinical symptoms, from mild manifestations such as dry cough and fever to severe complications, including multiple organ failure (MOF) and acute respiratory distress syndrome (ARDS) [1,2]. The disease was associated with high mortality rates, particularly among critically ill patients [3]. Since the start of the pandemic, significant advances have been made in vaccine development and distribution, and highly effective measures have been implemented to prevent the spread of the disease. However, there is evidence that COVID-19 will not be completely eradicated but will instead become endemic [2,4,5]. Although incidence and mortality rates are gradually declining, increasing attention is being focused on patients experiencing post-infectious complications. The persistence of symptoms following infection has been termed long COVID (LC) and encompasses a wide range of conditions that negatively impact patients' functioning [6]. Post-COVID-19 complications are highly heterogeneous; however, the most commonly reported involve pulmonary, neurological, cardiac, renal, and psychiatric systems [7-11]. Recently, there has been a growing number of studies focusing on the ophthalmic complications of COVID-19. In this review, we focus on the most frequently described ophthalmic manifestations and complications in the literature, with the aim of contributing to improved diagnosis and prevention of these complications.

2. Research materials and methods

A literature search was conducted in February 2026 using the PubMed database. The following search strategy was applied: (COVID-19 OR SARS-CoV-2) AND (ocular OR ophthalmic OR eye) AND (complications OR manifestations). Studies published in English since January 2020 were included. Initial screening was based on titles and abstracts, followed by full-text analysis of the selected articles. Exclusion criteria included case reports with insufficient clinical data, non-English publications, and studies published before January 2020.

The limitations of this review include its narrative design and the heterogeneity of the included studies.

3. Results

3.1. Acute macular neuroretinopathy

Acute macular neuroretinopathy (AMN) is a rare condition with acute onset. It is characterized by the presence of intraretinal, reddish-brown, wedge-shaped lesions in the macula, pointing toward the fovea. The etiology is multifactorial, although microvascular mechanisms are most commonly implicated. It most frequently occurs in young women and is associated with risk factors such as hormonal contraception, caffeine intake, and preeclampsia [12-14]. Characteristic symptoms include central scotoma, sudden-onset photopsia, and mild visual impairment [14]. Recent studies suggest a potential role of SARS-CoV-2 infection in the etiology of this condition [15,16].

In an observational study, Mei et al. characterized imaging findings and ocular symptoms in patients with post-COVID-19 infection in China. The study group included 18 patients who were followed by an ophthalmologist for at least 12 months. Scotomas were observed in all patients at the initial visit, along with hyperreflective changes in the photoreceptor layer and abnormalities in the normal laminar architecture. Areas of hyporeflection in the macular region were also identified in 5 of 18 patients. Notably, these abnormalities persisted for at least one year in all cases. These findings suggest that AMN may represent a significant long-term ocular manifestation of COVID-19 [15].

A study by Song et al. also reported a correlation between the increased incidence of AMN and SARS-CoV-2 infection. The study included 33 patients, both male and female, with a median interval of 2 days between the onset of fever and the development of ocular symptoms, suggesting a significant association between these events. Patients presented with central, paracentral, and peripheral scotomas. Characteristic retinal changes of AMN were observed, along with paracentral acute middle maculopathy (PAMM), intraretinal hemorrhages, and cotton wool spots. The study also demonstrated flow abnormalities, primarily in the deep capillary plexus, which may serve as a potential marker of microcirculatory disturbances in SARS-CoV-2 infection [16].

3.2. Acute angle closure

Glaucoma is an optic neuropathy characterized by progressive degeneration of retinal ganglion cells, leading to visual field loss. It is one of the most common causes of irreversible blindness. The pathogenesis is multifactorial, although elevated intraocular pressure (IOP) is the main modifiable risk factor. Glaucoma is classified into open-angle and angle-closure types [17,18]. The risk of developing the disease is higher in older adults, women, and individuals of Asian descent [19]. Acute angle-closure glaucoma (AACG) is an ophthalmic emergency associated with acute angle closure (AAC), which, if left untreated, may lead to irreversible damage and potential vision loss. It is characterized primarily by severe ocular pain, ocular redness, nausea, and vomiting, as well as rapidly progressive visual disturbances [20].

A retrospective observational study conducted in 2023 analyzed the association between COVID-19 infection and primary acute angle closure (APAC), as defined in the study. The study included 171 patients hospitalized at the Glaucoma Center of the Eye, Ear, Nose, and Throat (EENT) Hospital of Fudan University (Fenyang Road Center), Shanghai, China. Patients with COVID-19 were defined as those in whom symptoms of APAC occurred within 2 days before or up to 5 days after the onset of COVID-19 symptoms. Inclusion criteria included elevated IOP, a history of vision loss or blurred vision, and accompanying symptoms such as nausea, vomiting, ocular pain, a closed-angle configuration, corneal edema, conjunctival congestion, shallow anterior chamber depth, and an irregular, unresponsive, or dilated pupil. It was observed that patients in the COVID-19-positive group were younger than those in the negative group, and fewer had a history of previous APAC attacks. These findings suggest that COVID-19 infection may act as a factor accelerating the development of APAC. Furthermore, COVID-19-positive patients exhibited increased anterior chamber depth. Patients infected with SARS-CoV-2 also showed a larger pupil diameter and a greater tendency toward pigmented keratic precipitates (KP), suggesting a more severe disease course in these patients [21].

Similar conclusions were drawn in a study by Zhang et al., which retrospectively analyzed data from 84 patients. In this cohort, patients who tested positive for SARS-CoV-2 nucleic acid or antigen during an AAC episode were identified; these included both symptomatic and asymptomatic individuals. The results indicated that the incidence of bilateral attacks was significantly higher in the COVID-19 group. Furthermore, these patients

presented with more severe ocular findings. In some cases, a complete loss of iris elasticity was observed. Higher mean IOP values and larger pupil diameters were also found in the COVID-19 group. More pronounced features of anterior segment inflammation were observed, including pigmented KP, segmental iris atrophy, and the Tyndall effect in the anterior chamber [22].

In another study, Wang et al. analyzed the impact of factors related to daily activities during COVID-19 infection on the incidence of AAC. This multicenter study included 3,216 cases of AAC, the majority of whom were women over the age of 60. AAC was defined by the presence of ocular or periocular pain, IOP >21 mmHg, nausea or vomiting, episodes of intermittent blurred vision with halos, and at least one of the following: a centrally dilated, unresponsive pupil; corneal edema; conjunctival hyperemia; or a shallow anterior chamber. Patients were divided into non-COVID-19 and COVID-19 groups (definite COVID-19-symptomatic infection confirmed by testing; suspected COVID-19-defined as a history of contact with an infected individual, fever, and other symptoms). The number of AAC cases nearly tripled following the end of the zero-COVID policy period compared with previous years. Patients with AAC in the COVID-19 group exhibited certain lifestyle changes, including poorer sleep quality, higher water intake, and prolonged exposure to dark environments. More than half of the patients in this group used analgesics or antipyretics. An increased risk of blindness was observed in this group, reflected by higher IOP, more severe corneal edema, and poorer uncorrected distance visual acuity (UDVA). These findings suggest that behavioral factors associated with COVID-19 infection may play a significant role in triggering AAC in predisposed individuals [23].

3.3. Uveitis

Uveitis is a term encompassing anterior uveitis, posterior uveitis, and panuveitis, with anterior uveitis being the most common form [24,25]. Its etiology may be infectious, autoimmune, or idiopathic [26]. It is associated with blurred vision, photophobia, floaters, and eye redness, and if left untreated, may lead to vision loss [24]. The association between uveitis and viral infections is not fully understood, but an increased number of reported cases has been observed during the COVID-19 pandemic [26,27].

Feng et al. conducted a retrospective, single-center observational study involving 18 patients who experienced a first episode or recurrence of uveitis within 4 weeks of confirmed

SARS-CoV-2 infection. Half of the patients were diagnosed with de novo uveitis, while the others experienced reactivation of previously controlled disease. The mean age of the patients was approximately 40 years, and the majority were women. The clinical spectrum was diverse and included anterior, intermediate, and posterior uveitis, as well as panuveitis. In several cases, autoimmune conditions were identified, such as Vogt-Koyanagi-Harada (VKH) syndrome and multiple evanescent white dot syndrome (MEWDS), suggesting a potential immunological mechanism following viral infection. In some patients, visual acuity was reduced at the time of diagnosis but improved following treatment initiation. Treatment included topical and systemic corticosteroids, and immunosuppressive therapy was used in selected cases. In all patients, the inflammatory process was controlled and functional outcomes improved, with no reported adverse effects. The authors noted that the temporal association between SARS-CoV-2 infection and the onset of active uveitis, both primary and recurrent, suggests a potential role of COVID-19 as a trigger for immune responses within the uveal tract [26].

A retrospective clinical study by Ganesh and Mohanan-Earatt aimed to describe the profile of patients presenting with uveitis within 6 weeks of SARS-CoV-2 infection. The analysis included 13 patients who presented with uveitis without an identifiable alternative cause apart from a history of COVID-19 infection. The mean age of the patients was approximately 40 years, and the cohort included both men and women, with a predominance of bilateral involvement. In the study group, anterior uveitis was the most common form (7 patients), followed by intermediate uveitis (3 patients), posterior uveitis (1 patient), and panuveitis (2 children), indicating a broad spectrum of uveitis in the context of COVID-19. Secondary rhegmatogenous retinal detachment developed in one patient, requiring surgical intervention. Treatment consisted of topical and systemic corticosteroids, as well as mycophenolate mofetil, depending on the severity of inflammation. The majority of the patients responded well to treatment, achieving stabilization of inflammation and improvement in visual acuity at the final follow-up visit. Two cases of panuveitis resulted in complications, such as post-traumatic cataract, which required further intervention. The findings suggest that uveitis may represent an important, although rare, ophthalmic complication following COVID-19 infection, encompassing a spectrum ranging from mild anterior uveitis to panuveitis. The authors emphasize the need for prompt initiation of appropriate anti-inflammatory therapy, which is crucial for preserving visual acuity and limiting complications [28].

3.4. Mucormycosis

Mucormycosis is an acute, highly invasive fungal infection caused by fungi of the order Mucorales, most commonly of the genus Rhizopus. This disease is angioinvasive in nature and leads to thrombosis and subsequent tissue necrosis. It is associated with a high mortality rate [29,30]. During the COVID-19 pandemic, an increased number of reported cases of mucormycosis developing during or after SARS-CoV-2 infection has been observed. This phenomenon has been termed COVID-19-associated mucormycosis (CAM) [31,32].The most commonly described clinical presentation is rhino-orbital-cerebral mucormycosis (ROCM), which involves the paranasal sinuses, orbit, and intracranial structures [31]. Diabetes is the most commonly reported comorbid condition; however, other conditions associated with immunosuppression also contribute to its development [29,31]. Typical clinical symptoms include headache, facial pain, rhinitis, and orbital swelling; the diagnosis is confirmed by the identification of fungal hyphae in the affected tissue [29].

The clinical, prognostic, and demographic characteristics of patients with CAM were evaluated in a multicenter prospective observational study conducted in 2024. The median interval between the onset of COVID-19 infection and CAM was 25 days. Males were more frequently affected, and the mean age was approximately 56 years. The most common comorbidities included diabetes and cardiovascular diseases. Although 92.3% of patients had ocular involvement, bilateral involvement was observed in only 6.7%. The most common clinical manifestation was orbital and periorbital swelling, while chemosis was the most frequently observed finding on slit-lamp examination. Microvascular complications, such as central retinal artery occlusion, central retinal vein occlusion, and branch retinal vein occlusion, were identified in 45 eyes. The study reported a mortality rate of 11%, with factors associated with increased risk of death including a history of smoking, higher CAM severity, intensive care unit (ICU) admission, and ocular involvement. In contrast, in this cohort, the use of systemic corticosteroids was associated with lower mortality, which may reflect their beneficial effects in the management of COVID-19 rather than a direct impact on mucormycosis. It was also observed that patients whose treatment resulted in death had lower visual acuity at the time of CAM diagnosis compared to patients who were discharged from the hospital [33].

A retrospective clinical study conducted in 2022 analyzed the histopathological features and clinical course of COVID-19-associated rhino-orbito-cerebral mucormycosis (C-ROCM) in 89 patients. Symptoms of mucormycosis developed in approximately 47.2% of patients within 14 days of COVID-19 diagnosis. The predominant symptoms included periorbital or facial swelling and facial or orbital pain. Eighty-two patients received corticosteroid therapy for COVID-19. Central nervous system (CNS) and orbital involvement with vision loss were identified as poor prognostic clinical features of C-ROCM. In contrast, angioinvasion and minimal neutrophilic inflammation were identified as adverse histopathological prognostic features. The study also highlighted complex interactions between COVID-19 and uncontrolled diabetes, with ketoacidosis being associated with a poor prognosis [34].

Rajabi et al. conducted a retrospective observational study at seven centers in Iran, defining C-ROCM as confirmed mucormycosis occurring in patients who had recovered from COVID-19. Data from 132 patients were analyzed, with the most commonly reported symptoms being paresthesia, visual disturbances, and facial pain. Diabetes was among the most common comorbidities. Interestingly, the severity of COVID-19 symptoms was significantly associated with mortality and severe visual disturbances. However, no significant association was found between medications used in C-ROCM and COVID-19 vaccination. The use of corticosteroids in the treatment of COVID-19 was associated with an increased risk of complications. Other contributing factors included poor glycemic control during and after COVID-19 infection, as even patients without a prior history of diabetes exhibited hyperglycemia and, in some cases, required admission to the ICU. These findings emphasize the importance of appropriate corticosteroid use in COVID-19 treatment and strict adherence to therapeutic protocols [35].

Yadav et al. reported corneal manifestations in patients with C-ROCM. Thirty-two out of 220 patients presented with corneal involvement. These patients were more often men aged 41-60 years, and all had a history of COVID-19 infection. Furthermore, diabetes was identified as a risk factor in 90% of cases, and 60% had a history of inappropriate corticosteroid use. Nine patients were diagnosed with round-to-oval corneal ulcers, while three patients developed corneal melting and conjunctival xerosis with chemosis. Six patients underwent orbital evisceration, of whom five recovered [36].

In a retrospective analysis of 46 cases of CAM conducted by Lam et al., the focus was on clinical presentation, demographic characteristics, and predisposing factors. Most cases

involved middle-aged men. The median interval between COVID-19 diagnosis and the onset of ROCM symptoms was 25 days. The most commonly reported symptom was visual impairment, with proptosis observed in 65.2% of patients and blepharoptosis in 23.9%. Diabetes, corticosteroid use, and elevated serum ferritin levels were identified as risk factors. Forty-four patients received transcutaneous retrobulbar amphotericin B (TRAMB) injections, which demonstrated significant efficacy in improving visual acuity. All patients underwent sinus debridement via functional endoscopic sinus surgery (FESS), with or without medial orbital wall decompression and lateral canthotomy. In 36 patients, both clinical and radiological improvement was observed within 10 days after surgery. The authors concluded that the combined use of TRAMB injections, systemic antifungal therapy, and prompt surgical orbital decompression may lead to complete resolution of orbital mucormycosis. However, they also emphasized the importance of regular monitoring of blood glucose levels in this context [37].

4. Discussion

The available data indicate that ophthalmic complications following SARS-CoV-2 infection are multifactorial in nature and include both acute manifestations associated with the course of the infection and long-term consequences resulting from immunological and vascular mechanisms [15,16,21-23,26,28,33-37]. The clinical manifestations of the described complications are summarized in Table 1.

In the case of AMN, the results of the analyzed studies are consistent with a growing body of evidence indicating a significant association with SARS-CoV-2 infection [15,16,38]. The association between AMN and viral infections is not a new phenomenon, as cases have been reported following infections such as Epstein-Barr virus [14]. Of particular significance is the observed persistence of structural retinal changes lasting for more than 12 months, suggesting a chronic nature of the damage and supporting the classification of AMN as a long-term complication of COVID-19 [15]. The symptoms of AMN described in the analyzed studies are consistent with those typically reported in the literature, including sudden onset with scotoma [13,15,16]. The described perfusion abnormalities are consistent with the theory, supported in the literature, of a vascular origin of AMN. Extensive defects in deep retinal perfusion may serve as biomarkers of impaired microcirculation in COVID-19 [16,39].

With regard to studies on angle-closure disease, it is noteworthy that patients with COVID-19 appear to develop the condition at a younger age [21]. The symptoms of AAC,

including APAC, reported in the analyzed studies did not differ from those typically described in the literature. They included both ophthalmic symptoms, such as visual disturbances and eye pain, and general symptoms, such as nausea and vomiting [20,21,40]. However, the analyzed studies showed that the COVID-19-positive group exhibited more severe symptoms, higher IOP values, larger pupil diameters, and more pronounced anterior segment inflammation, suggesting a more aggressive disease course [20,21,23]. The literature highlights established risk factors for AACG, including female sex, Asian ethnicity, and the use of antidepressants such as SSRIs. However, the study by Wang et al., which analyzed AAC episodes in the context of COVID-19, provides a complementary perspective by suggesting that situational and behavioral changes, such as impaired sleep quality, prolonged exposure to dark environments, and the use of antipyretic medications-may act as triggering factors in predisposed individuals [23,41-43].

The results of the analyzed studies on uveitis suggest that this condition may represent a post-COVID-19 complication, occurring both as a de novo condition and as a recurrence of pre-existing disease [26,28]. The presence of autoimmune conditions, such as VKH syndrome and MEWDS, further supports the hypothesis of an immunological pathogenic mechanism, as described in the literature [26,44,45]. An important clinical aspect is the good response to anti-inflammatory treatment, particularly corticosteroids, which in most cases led to control of the inflammatory process and improved visual acuity. However, this observation contrasts with reports on CAM, in which systemic corticosteroid use is one of the main risk factors for the development of severe fungal infection. This points to a complex, dual effect of immunosuppressive therapy in the context of COVID-19-related ophthalmic complications [26,28,35,36].

With regard to mucormycosis, it should be noted that the disease typically develops several weeks after COVID-19 infection, indicating that the recovery period represents a time of increased risk for opportunistic complications [33,37]. A key feature of the analyzed studies is the high prevalence of diabetes and carbohydrate metabolism disorders among patients with mucormycosis. Even in those without a prior diagnosis of diabetes, hyperglycemia was observed during COVID-19. More severe disease and ICU hospitalization were associated with poorer outcomes and higher mortality, consistent with previously published data [31,33,35,36,46]. With regard to treatment, the importance of early diagnosis and aggressive therapeutic management, including antifungal therapy and surgical intervention, was emphasized. Reports on the efficacy of combination therapy with

amphotericin B and surgical procedures suggest that prognosis can be improved if treatment is initiated promptly [33,35,37].

Table 1. Clinical manifestations of COVID-19-associated ophthalmic complications based on analyzed studies

Disease entity	**Temporal relationship with COVID-19**	**Main reported symptoms**	**Clinical course**	**References**
Acute macular neuroretinopathy	~0.5-5 days after fever onset	central, paracentral, and peripheral scotomas	possible long-lasting retinal changes (>12 months)	[15,16]
Acute angle closure	within 2 days before to 5 days after symptom onset	eye pain; blurred vision; halos; nausea; vomiting	acute, potentially more aggressive course in COVID-19 patients	[21-23]
Uveitis	within 3-6 weeks after infection	decreased visual acuity	variable course; de novo onset or recurrence	[26,28]
Mucormycosis	mean ~14-25 days after COVID-19	facial/orbital pain; visual disturbance; vision loss; facial paresthesia	severe, potentially life-threatening	[33-37]

5. Conclusions

Ophthalmic complications associated with SARS-CoV-2 infection constitute a heterogeneous group of disorders involving vascular, inflammatory, and infectious

mechanisms. During the course of COVID-19, ischemic retinal changes such as AMN have been observed, with pathogenesis likely related to microcirculatory disturbances. Similarly, AAC may present with a more complex and potentially more severe course in this context, partly related to behavioral factors. Uveitis also remains a significant issue, as it may develop following SARS-CoV-2 infection either as a de novo condition or as a reactivation of an autoimmune disease. This suggests the involvement of immunological mechanisms and underscores the importance of prompt initiation of anti-inflammatory therapy, including corticosteroids, which remain effective in controlling inflammation. On the other hand, attention should be paid to the potential adverse effects of steroid therapy, particularly in the context of CAM. This is a severe infectious complication, the risk of which increases significantly in patients with diabetes and in those receiving corticosteroid therapy, requiring particular caution in treatment selection. In summary, ophthalmic complications of COVID-19 are complex and require an individualized therapeutic approach. It is crucial to balance the effective treatment of inflammatory processes with minimization of infectious complications, as well as to closely monitor patients, especially those with risk factors such as diabetes. Further studies in large cohorts are required to better characterize these associations.

Disclosure Section

Author Contributions

Conceptualization: KC, PB; methodology: KC, PB, PM investigation: KC, PB, PM, JB, AGG, PH, MK; resources KC, PB, PM, JB, AGG, PH, MK; writing-original draft preparation: KC, PB, PM, JB, AGG, PH, MK; writing-review and editing: KC, JB, AGG, PH, MK; visualization: KC, PB; supervision: KC;

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Conflicts of Interest

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