Abstract

In response to climbing global case and fatality rates of the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and its associated disease, COVID-19, ophthalmology practices have modified their clinical and operative approach to patient care in an attempt to reduce spread of the virus. The presence of SARS-CoV-2 viral RNA in the preocular tear film raises speculation that the ocular surface can act as an initial site of infection as well as a potential source of person-to-person viral transmission. More recently, conjunctival specimens and immunohistochemical analyses have identified the presence of cellular surface factors necessary for SARS-CoV-2 infection on the ocular surface. Together, these results highlight the importance of safety measures in ophthalmology practices to prevent transmission of SARS-CoV-2. As ophthalmic exams typically require close proximity between a patient’s respiratory tract and the provider, clinical and surgical recommendations are aimed at reducing unnecessary patient-provider interactions. Subspecialty professional guidelines can be used to instruct ophthalmologists on the necessity of various procedures and best practice measures. Ophthalmology practice during the COVID-19 pandemic has been dramatically curtailed in an effort to reduce the risk of transmission and conserve valuable personal protective equipment (PPE), and the impacts of the ongoing pandemic on ophthalmology practices will be felt for the foreseeable future.

Keywords

COVID-19 · SARS-CoV-2 · Ophthalmology

Introduction

The novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and its associated disease, COVID-19, have rapidly spread from its apparent origin in Wuhan, China, to nearly every country on Earth [1]. At present, there are nearly 50 million confirmed cases and well over one million deaths globally, though these numbers are almost certainly underreported as a consequence of insufficient testing capabilities and an increasing awareness of minimally or asymptomatic infections [2, 3].

Following the first wave of the pandemic, much attention has been devoted to the impact of COVID-19 on healthcare systems and the healthcare personnel at risk of contracting and/or spreading the disease via contact with infected patients, exacerbating by documented shortages in personal protective equipment (PPE), hospital beds, and ventilators [4, 5]. Intense research focused on medical treatment, and vaccine development continues worldwide; however, to date, there remains no effective and widely available treatment or prevention for COVID-19 [6–10]. The knowledge and experience accumulated to date will guide recommendations in the ongoing second wave of the pandemic, which will inevitably reduce patient access to healthcare, both as a means of preserving hospital resources and the reluctance of patients to enter health care facilities.

In response to continuously climbing global case and fatality rates, many regions may again consider regulations aimed at postponing or curtailing non-urgent or emergent medical care, including outpatient visits and non-essential surgical procedures. Almost all disciplines, including ophthalmology, have modified their clinical and operative approach to patient
care in an attempt to reduce demand on health care systems and reduce viral spread [11]. Consequently, ophthalmologists and patients have been forced to choose between the risk of vision loss from a delay in ophthalmic care and contracting the potentially fatal SARS-CoV-2 virus. Professional guidelines for eye care during this crisis are both necessary and helpful for physicians and patients to navigate the crisis; in the USA, many ophthalmologists have deferred elective procedures since March 2020 in accordance with guidance from the American Academy of Ophthalmology (AAO), American College of Surgeons’ (ACS), and Centers for Medicare and Medicaid Services (CMS), with endorsement from a majority of ophthalmic subspecialty professional societies [12–14].

This article attempts to review the ocular manifestations of the SARS-CoV-2 and the impact of the COVID-19 pandemic on the practice of ophthalmology. We will also attempt to summarize recommendations regarding outpatient and perioperative care based on current evidence and guidelines. As more data becomes available, it is likely that the strategies outlined herein will change accordingly.

**Ocular Involvement in COVID-19**

Anatomically, the nasolacrimal duct connects the nasal cavity of the upper respiratory tract to the mucosa of the ocular surface, acting as a conduit for pathogens between the eye and the respiratory and gastrointestinal tracts. Conjunctival specimens and immunohistochemical analyses have revealed that the ocular surface and the gastrointestinal tract share receptors necessary for respiratory viral infection. The angiotensin-converting enzyme 2 (ACE2) surface receptor, a metallopeptidase, facilitates spike protein binding on numerous respiratory viruses, including SARS-CoV-2, while the transmembrane protease serine 2 (TMPRSSR) enzyme allows for entry following receptor binding [15–17]. Prior research on coronaviruses following the SARS-CoV outbreak in 2003 revealed viral entry is also modulated by other factors on host cell membranes including heparin sulfate proteoglycans (HSPGs); given the similarities in the spike proteins and entry receptors between the two viruses, it has been postulated that HSPGs, which are also present on the ocular mucosa, may act as an attachment receptor for SARS-CoV-2 [18, 19].

Numerous investigators have also reported the presence of viral RNA in ocular discharge and conjunctival swabs; however, the rate of positives by RT-PCR remains low and attempts to culture SARS-CoV-2 from the preocular tear film has thus far been unsuccessful [20–22]. As such, the infectivity and clinical importance of tears as a viral transmission vector is not well understood, yet a growing body of evidence indicates that SARS-CoV-2 can cause ocular abnormalities in infected patients.

Studies suggest that conjunctival abnormalities are present in up to 31.6% of patients with a COVID-19 diagnosis, with some patients reporting conjunctivitis as the first symptom [23, 24]. In addition, multiple case reports have identified a potential association between COVID-19 and Kawasaki Disease (KD) in children, a symptom of which can include significant ocular injection [25, 26]. Because of this association, pediatric providers must maintain a high suspicion for the disease in COVID-19-positive patients, especially in those who present with conjunctivitis. These findings raise speculation that the ocular surface may act as an initial site of infection as well as a potential source of person-to-person viral transmission and highlight the importance of safety measures in ophthalmology practices, including facemasks and ocular contact precautions in order to prevent transmission of SARS-CoV-2.

**Impacts of COVID-19 on the Practice of Ophthalmology**

**Intake Precautionary Measures**

In accordance with many governmental and medical governing board regulations, patients are advised to avoid unnecessary travel to healthcare facilities in order to minimize the risk of exposure to SARS-CoV-2 and prioritize PPE allocation to frontline healthcare workers [27]. Like other medical specialties, ophthalmology providers are advised to defer many non-urgent or emergent appointments. Many providers have responded by taking advantage of relaxed regulations on telemedicine by expanding virtual services to maintain relationships with patients and preserve continuity of care rather than canceling appointments outright [28–30].

Of unique concern to ophthalmology clinics is the advanced average age the patient population. As many of the common ocular pathologies tend to affect older patients, including cataracts, glaucoma, and age-related macular degeneration (ARMD), these patients are at higher risk for adverse effects and death from COVID-19 [31, 32]. Accordingly, both physicians and patients must weigh the risks and benefits of in-person visits.

In cases where routine visits are deferred, physicians must counsel patients on early signs and symptoms of vision-threatening sequelae. Recent research on ophthalmic emergency services at a tertiary hospital has identified a concerning decrease in consultations for urgent pathologies including uveitis, retinal detachments, and macular pathologies, implying that patients may be either unaware of symptom urgency or otherwise reluctant to access the healthcare services necessary to manage important eye diseases [33].

In cases where in-person visits are indicated, it is recommended that all patients be screened for COVID-19 symptoms
prior to entering a healthcare facility through a combination of questions aimed at eliciting symptoms and exposures as well as objective screening mechanisms such as body temperature measurements. Patients and staff are advised to follow “social distancing” practices, maintaining at least six feet (or 2 m) between others in queues and waiting rooms [34, 35]. Given the presence of visual deficits in the ophthalmology patient population, caretakers often accompany patients to clinics; when applicable, all persons accompanying an ophthalmology patient should receive the same screening for COVID-19 and participate in precautionary measures.

Clinical Precautionary Measures

As ophthalmic exams typically require close proximity between a patient’s respiratory tract and the provider, clinicians are advised to use appropriate PPE when examining a patient, including facemasks and plastic slit lamp shields to minimize the risk of transmission [27]. Physicians should also attempt to minimize procedures that cause ocular irritation in order to prevent patients from rubbing or touching their eyes or faces. If such procedures are necessary, physicians must warn patients about the increased risk of contracting the disease from hand-to-face contact.

Clinical scenarios involving ocular manipulation are of particular concern given the possible presence of the virus in the preocular tear film; such procedures should be limited to those patients with clear indications, as infectious aerosol droplets can remain suspended for 3 h or more [36]. Standard examination techniques require addition precautionary measures to prevent viral transmission; for example, appplanation-based tonometry for the measurement of intraocular pressure (IOP) has the potential for direct cross-contamination from the probe tip while non-contact tonometry has the potential to aerosolize the virus from the ocular surface [36, 37]. Lastly, it is imperative that all surfaces and examination tools, including slit lamps, lenses, and imaging modalities, be properly disinfected between patient contacts, as SARS-CoV-2 can survive for many hours on surfaces [4, 36].

Within the field of ophthalmology, many subspecialties face unique SARS-CoV-2 considerations, which we briefly summarize below.

Retina

The patient population in retina clinics is unique given the high percentage of elderly patients and the presence of comorbidities, placing these patients at a higher risk for severe illness from COVID-19. Additionally, many visits involve an intraocular injection or require a fundus examination to prevent permanent vision loss, neither of which is amenable to telemedicine platforms [38, 39]. For patients undergoing intravitreal injection therapies (e.g., wet age-related macular degeneration or diabetic retinopathy), retina specialists would benefit from triaging patients to identify those at greatest risk of permanent vision loss and prioritize treatment visits over monitoring visits [38]. To further reduce patient risk, it is vital to enforce established policies such as not talking during injections and utilizing appropriate PPE for both patients and providers. Additionally, in order to minimize the number of clinic visits during the pandemic, clinicians may choose to transition to same-day bilateral injections and implement a treat and extend policy when feasible [39].

Ocular Oncology

Patients with ocular tumors present unique challenges to ophthalmologists given that ocular tumors are potentially fatal, yet mainstays of cancer treatment involve systemic immunosuppression, increasing the risk of developing COVID-19 [39]. Accordingly, treatment decisions should be made based on the individual risk-benefit profile of each patient; while some stable patient interactions are being shifted to telemedicine platforms, many others have chosen not to delay established treatment protocols, particularly in children, new patients, and those with active disease. Urgent procedures in the field of ocular oncology include orbital biopsy for suspected malignancy, brachytherapy, tumor excision, and enucleation [40, 41].

Uveitis

Uveitis patients undergoing immunomodulatory therapy (IMT) are classified as high risk in the COVID-19 pandemic [42]. There is ongoing research into the effects of IMTs on coronavirus infection and immune response; however, no formal guidelines have been issued to providers. Uveitis specialists should carefully analyze the risks and benefits associated with in-person encounters when deciding on a treatment course.

Surgical Precautionary Measures

Early in the pandemic, most elective surgeries were postponed in order to preserve PPE and reduce COVID-19 transmission. While PPE shortages are now of less concern, many hospitals have maintained a reduced operating room load in order to minimize patient volume and potential staff exposure. For ophthalmologists, priority is given to cases where a delay would result in negative impacts on patient outcome; however, an increasing number of elective surgeries (e.g., cataract extractions with intraocular lens placement) are being performed both to address the accumulated backlog and improve patient quality of life. For such cases, a patient’s COVID-19 status should be determined prior to surgery and the appropriate PPE utilized by the surgical team.
In patients with positive pre-operate PCR testing, it is prudent to consider delaying surgery given the possibility of rapid clinical deterioration and adverse surgical outcomes [43, 44]. Most institutions have developed individual protocols adapted from guidelines of World Health Organization (WHO); however, for patients with no suspicion or evidence of SARS-CoV-2, standard surgical PPE should suffice. For patients who are RT-PCR positive, or with evidence of antibodies to the virus, surgical teams should consider utilizing masks that efficiently filter airborne particle (e.g., N95 respirators), as well as reducing the surgical staff and minimizing in-out traffic in operating rooms [45].

The identification of aerosol-generating procedures is also essential to potential viral transmission to health care personnel [46]. As endotracheal intubation is known to generate aerosols, ophthalmic surgeries performed under general anesthesia may pose additional risk, and appropriate precautions should be used [47, 48]. Other routine ophthalmic procedures, including those that utilize ultrasound probes in the eye, are unlikely to create aerosol due to the closed nature of the surgical systems, and standard surgical protocols and field sterilization techniques are likely sufficient [44].

Returning to Practice

Following the first wave of the COVID-19 pandemic, many regions began the process of lifting COVID-19-related restrictions, including the reopening of ambulatory surgery centers (ASCs) and the resumption of limited elective surgeries [49]. While the regulatory environment around the ongoing second wave of the pandemic remains highly variable across regions, practices continue the transition toward normal functioning. This transition should be undertaken in a tiered approach in close coordination with hospital, local, and regional regulatory bodies to ensure patient and provider safety and preserve capacity in the healthcare system [49, 51]. In addition, the dynamic nature of the pandemic will necessitate ongoing assessment of new trends, data, testing, and treatments, and recommendations need to be reviewed and updated regularly.

For many patients, there is an increased desire to seek overdue clinical care as regulations ease. However, ophthalmology practices must remain vigilant about the possibility of outbreaks and adjust practice accordingly. Until reliable point-of-care testing or effective treatments or vaccines are widely available, ophthalmology practices and clinics should continue to mandate social distancing in waiting rooms, efficient patient turn-over systems to minimize idle time, frequent disinfectant of all patient areas and equipment, and PPE precautions [50]. As these practices will necessitate additional time between patient encounters, ophthalmologists may be forced to decide whether to book fewer patients on a given day or extend clinic hours [51]. Continued expansion of telemedicine platforms will also provide clinicians a way to reduce the burden of high patient volumes as clinics begin to reopen.

Finally, ophthalmology practices or healthcare systems may wish to institute a supervisory committee to oversee infection control measures and audit healthcare practices based on patterns of transmission (e.g., patient to patient, healthcare personnel to patient, patient to healthcare personnel, and surface to patient). Regional and global physician working groups may be utilized to share professional experiences and perspectives on the effect of the pandemic on practice, allowing the rapid dissemination of trends and best practices [32]. Adherence to best practice measures and active surveillance of COVID-19 remains crucial for minimizing viral transmission risk.

Conclusion

Ophthalmology practice during the COVID-19 pandemic has been dramatically curtailed in an effort to reduce the risk of transmission and conserve valuable PPE. As some regions report progress combating the pandemic, the scope of practice will broaden accordingly; however, caution is advised given the dynamic nature of the situation and the ongoing second wave of the pandemic. The impacts of the pandemic on ophthalmology practices will be felt for the foreseeable future, even after effective point-of-care testing, treatments, and vaccines are available. The recommendations summarized in this article are a snapshot of current practices, which are rapidly evolving and subject to change. Additionally, all recommendations should be considered in the context of local regulations, institutional policies, and local prevalence of disease.

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