



# Impact of the COVID-19 Pandemic on Refractive Surgery

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## Abstract

**Purpose of Review** In this article, we review the impact of the COVID-19 pandemic on refractive surgery.

**Recent Findings** COVID-19 infection frequently causes eye symptoms, most commonly conjunctivitis or mild irritation. While virus can be detected in tears of symptomatic patients, the risk of transmission via this route appears low.

**Summary** Refractive surgery consultations were significantly reduced during the pandemic; however, volume is rebounding quickly likely due to a number of lifestyle, health, and financial factors. Laser refractive and intraocular surgery likely confer a low risk of virus spread, especially in asymptomatic patients. Screening prior to the refractive consultation and surface disinfection in the clinic and operating room can help reduce transmission risk further.

**Keywords** COVID-19 · Refractive · Surgery · LASIK · Laser

## Introduction

According to the Centers for Disease Control and Prevention (CDC), as of June 2021, there have been over 33 million reported cases and nearly 600 thousand deaths resulting from COVID-19 in the USA alone [1]. After passing the 1-year mark since the beginning of the pandemic, the impacts on healthcare are becoming more apparent. With hospitals and private practices continuing to find ways of safely caring for patients, it is important to evaluate how COVID impacted the field of Ophthalmology and reflect on how this experience can help practitioners going forward. The field of Ophthalmology is unique in medicine for its dependency on the physical exam, and the face-to-face proximity of provider and patient during clinic and operating room encounters. This has made providing care safely during COVID challenging, especially for practices that focus on refractive procedures. Here, we consider the impact of

the pandemic on refractive surgery, discuss various factors behind the trends, and review how these lessons might inform patient care in the future.

## Review of COVID-19 Ophthalmic Manifestations

While the coronaviruses as a family have been shown to be capable of causing a wide range of ocular manifestations, including uveitis, retinitis, and optic neuritis, currently the SARS-CoV-2 variant has demonstrated only limited ocular disease. However mild, the eye is frequently involved. Current data suggests up to one-third of COVID-19 patients may experience ocular symptoms [2]. In fact, eye complaints may be the initial or even only symptoms in a patient with COVID-19 [3, 4]. The most common ocular manifestations reported are conjunctivitis and eye soreness with hyperemia, chemosis, epiphora, and increased secretions less commonly reported [2, 5, 6]. Mechanisms by which the virus causes ocular symptoms are thought to include direct inoculation via aerosolized droplets, hematogenous spread via the lacrimal gland, and migration from the nasopharynx [7].

The tears and conjunctival secretions of patients with COVID-19-related conjunctivitis have been shown to be more likely to contain virus than the secretions of COVID-19 patients without ocular symptoms [8]. However, it

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appears the risk of transmission via tears is low [9–11]. Of note, no studies currently suggest that COVID-19-related conjunctivitis should be treated differently than viral conjunctivitis caused by more common culprits. Aside from treatment for the systemic manifestations of the disease if indicated, conservative therapy to help relieve ocular symptoms is recommended.

Notably, coronaviruses are capable of *in vivo* mutations which may drastically alter the characteristics of the disease, and new variants of COVID-19 virus are already being recognized [7]. The CDC is reportedly monitoring several “Variants of Concern” of the SARS-CoV-2 including the Delta Variant [12]. This likely means the full impact of the COVID-19 disease on the eyes will not be fully understood for some time.

### COVID-19 Impact on Refractive Volume and Future Trends

Despite limited ocular involvement, the COVID-19 pandemic has impacted the field of refractive surgery uniquely within the field Ophthalmology. Compared to other specialties, Ophthalmology experienced one of the largest decreases in patient visits due to the pandemic. Visits the week of April 5th 2020 were down 79% compared to the week of March 1st 2020 (hereafter referred to as baseline or pre-pandemic levels). This decline lessened somewhat to a relative 39% decline by May 10th 2020 [13]. However, Ophthalmology was also quick to rebound compared to other specialties. By the week of October 4th 2020, visits were up 4% compared to baseline while most specialties remained depressed [14]. This increase was sustained through the end of the year with visits during the last 3 weeks of 2020, up 3% compared to pre-pandemic levels. Notably, this was without the help of telemedicine as Ophthalmology was the only specialty surveyed that reported a 0% increase in telemedicine visits during the pandemic. Some practices however have reported successful implementation of teleophthalmology, with one practice reporting virtual visits comprising one-third of total visits helping to offset a decrease in surgical volume of 20% [15]. The increase in visits as the pandemic eased does not appear to have fully negated the preceding decrease in visits, with a cumulative decline of 18% reported as of late 2020 compared to baseline [16].

As practices reopened for elective services, physicians were unsure about what to expect regarding patients’ desire for refractive surgery. Perhaps surprisingly, many practices saw refractive consults increase to and then surpass pre-pandemic levels in the USA and abroad [17–19]. The Refractive Surgery Council reports a 16.3% increase in procedures in the last quarter of 2020 compared with the previous year, with some practices reporting 200% increases in refractive

leads in June 2020 compared to the first months of the year [19, 20]. This suggests that refractive visits are recovering more quickly than other types of Ophthalmology visits.

While the recovery was a welcome change, practices may have been surprised by the unexpectedly sudden increase in volume. In recent months, practices have found themselves facing the logistical challenges of caring for a surge in patients during a pandemic while rebuilding staff that may have taken extended leave due to childcare needs or even been furloughed [19]. This may have delayed some practices’ ability to capitalize on the new demand.

The increase in refractive consults may be a transient spike caused by the compression of patients who would have otherwise presented over a longer period had the pandemic not prevented or discouraged a visit. However, this is likely only one of many factors at play. As with any elective procedure, financial factors are one of the largest motivators. Economic impacts of the pandemic have been widespread, with many experiencing lasting financial hardship [21]. General patients seeking refractive surgery tend to be younger, usually 20–40. A study in 2015 found the average age of LASIK patients was 27 [22]. This age range fits almost exclusively within the Millennial cohort, or Generation Y, widely defined as those born between 1981 and 1996 [23]. Surveys have demonstrated that Millennials are more likely to have had a negative impact on their finances due to the COVID-19 pandemic, and the financial impact itself tended to be more severe than that reported by other generations [21]. This apparent decrease in available discretionary spending has been accompanied by a lack of opportunity to spend in general. Record numbers of adults found themselves working from home with few opportunities to spend on retail or recreation [24].

The patient cost for LASIK and PRK varies considerable by provider and region, with the average likely between \$2000 and \$3000 per eye [25]. In recent months, most patients who would be considered candidates for refractive surgery have also been able to receive federal financial relief. In the last year, there have been three rounds of stimulus. As an example: a qualifying single adult earning less than \$75,000 a year would have received \$1200 under the CARES Act, \$600 under the Consolidated Appropriations Act, and \$1400 under the American Rescue Plan, totaling \$3200 [26]. With the limited opportunity to spend recreationally, it is possible that many patients considered refractive surgery a way to invest in themselves during an uncertain time. The pandemic has also likely created a sense of unpredictability about the future for many patients, adding to a “If not now, when?” mentality. This seems to be manifesting not only as increased refractive volume, but also increased conversion rates to premium lenses [27].

Lifestyle changes are likely another large motivator for patients seeking refractive surgery. Along with the

transition to working from home during the pandemic, there has been an increase in screen time [28]. Symptoms of burning and irritation related to dryness have been shown to be exacerbated by increased screen time, likely due to the decreased blink frequency [29]. While Dry Eye Disease is more prevalent among older patients, dry eye symptoms are still common among the younger cohort of patients typically seeking refractive surgery [30]. This could be a motivator for patients who rely on soft contact lenses, a known risk factor for dry eye. Soft contact lens wearers with dry eye have been shown to experience more frequent and intense symptoms of dryness than non-wearers [31]. Hygiene concerns may further motivate contact lens wearers during the pandemic, and researchers have suggested that these patients are likely at increased risk for transmission of the COVID-19 and other viruses due to more frequent contact with the face and ocular surface [32].

For patients who rely on glasses, frequent mask wear has worsened a troublesome phenomenon. Face coverings can direct warm breath upward to the cooler lenses causing problematic condensation and fogging. Incidentally, the redirected air can also contribute to symptoms of dry eye [29]. Masks that are supported by ear straps can become caught on spectacle earpieces and contribute to a feeling of crowding around the face, especially for those wearing headphones or earbuds. For patients who need to comply with new requirements for eye protection and/or facial shielding at work due to the pandemic, refractive surgery offers patients more flexibility outside the limitations of prescription-only eye protection without the worry of soft contact lenses.

From a wider perspective, the increase in near work, screen time, and decrease in outdoor activity that has accompanied the COVID-19 pandemic could exacerbate a larger trend toward near work-induced myopia that may not be fully appreciated for years [33, 34]. Online work may also make patients more cognizant of their appearance and may further motivate a cosmetic desire to be spectacle free. Online meetings and classes have also likely allowed for an increased flexibility in many patients' schedules allowing greater freedom for patients to schedule appointments, as well as undergo and recover from procedures [35]. The physician's schedule has also been impacted by the increased popularity of online encounters. Where previously telehealth may have been considered a lesser substitute for in-person consultation, many patients now view it as convenience and more physicians are advertising virtual care options [36]. While the testing and physical exam still make a physical appointment a necessary component of a refractive evaluation, some refractive surgeons may find virtual visits to be an efficient and flexible platform for reviewing testing, discussing options [27]. Several free HIPAA-compliant video communications platforms are available for this purpose [37].

Some have suggested immediate sequential bilateral cataract surgery (ISBCS) can help more efficiently care for the backlog of patients that have accumulated during the pandemic [38]. Further benefits include reduced risk of exposure and, if required, one less COVID test. With demand for cataract surgery continuing to grow along with patient expectations, ISBCS may be a great option for many surgeons [39]. Surveys show that most patients and surgeons prefer ISBCS over the separate-day alternative; however, reimbursement changes will need to be made before this practice can be more widely adopted [40].

### Safety Considerations for Refractive Surgery During COVID-19

The durability of the SARS-CoV-2 virus is of interest to better guide clinic and operating procedures for transmission reduction. As many instruments in refractive surgery are near the patient's airway and mucous membranes, the cleaning of instruments and equipment in the operating room and clinic is of importance. Data currently suggests that the virus can stay viable as an aerosol for up to 3 h and intact on surfaces like plastic and stainless steel for up to 3 days [41]. However, the ability to transmit the virus via hard surfaces is likely limited, with aerosol spread being the primary mode of concern [42]. It is recommended to regularly clean surfaces with a commercially available disinfectant, as well as sterilize instruments that come into contact with ocular tissues after every use [43, 44]. In the clinical setting, protective breath shields attached to slit lamps have shown promise in reducing the risk of aerosol spread [45].

One of the best ways physicians can protect themselves, their staff, and patients is by getting vaccinated. Simple changes to clinic and operating room flow can further reduce the risk of transmission. This begins with patient screening prior to the refractive consultation, ideally prior to an in-person interaction via online appointment software. Questions might focus on the following: recent sick contacts, recent travel outside the country, and symptoms including fever, cough, shortness of breath, myalgia, loss of smell, and loss of taste. The American Society of Anesthesiologists currently recommends COVID-19 PCR testing for all patients undergoing elective surgery regardless of vaccination status [46]. Policies regarding perioperative testing will likely vary by institution with some facilities possibly forgoing testing for fully vaccinated patients. A patient is considered fully vaccinated 2 weeks after the second dose of the Pfizer-BioNTech and Moderna vaccines and 2 weeks after receiving Johnson & Johnson's Janssen COVID-19 vaccine which only requires one shot [47].

As previously discussed in the section on ocular manifestations, the presence of SARS-CoV-2 virus in the tears of

patients has been well documented. While the risk of infection via contact with infected tears is unlikely, it is worth discussing safety measures to reduce risk of transmission during surgery. Regarding laser procedures such as LASIK, PRK, SMILE, and PTK, the safety of the excimer laser on the ocular surface in the setting of SARS-CoV-2 in the tear film is unknown. A study attempting to culture varicella zoster virus from the laser plume after ablation of infected fibroblasts was unsuccessful, suggesting the virus did not survive intact [48]. While the morphology of herpes viruses such as varicella zoster differs significantly from coronaviruses, it is likely that the laser is destructive to viral particles [49]. Of further comfort is the fact that many current excimer systems are equipped with aspiration systems with HEPA filtration. Intrastromal ablation with femtosecond lasers would likely confer even less risk. Even so, sterilization of the ocular surface with povidone-iodine and BSS irrigation prior to laser refractive surgery is recommended [50].

For patients who wear a mask during surgery, it has been shown that breath is directed upwards toward the patient's eyes [51]. While patients who are known to be COVID positive will likely not be undergoing elective refractive surgery, this phenomenon is worth considering in unvaccinated patients with unknown COVID status. The above phenomenon was significantly reduced by taping the top border of the patient's mask. Studies with model eyes suggest that phacoemulsification can produce aerosols which could contain live virus although this would be very unlikely in the asymptomatic patient [52]. It is worth mentioning that there are some concerns that COVID-19 infection and the vaccine itself could increase propensity for inflammation in the eye, particularly in patients with a history of uveitis [53–55]. Although the impact on surgical practice is not yet understood, it has been suggested that even after recovering from COVID-19 infection patients could be at higher risk for Toxic Anterior Segment Syndrome (TASS), with one such case reported after phakic IOL placement [56].

## Conclusions

Ophthalmology was one of the most negatively affected specialties during the pandemic. However, as the world returns to normal, there has been an increased number of patients seeking refractive surgery compared to pre-pandemic levels likely due to a myriad of lifestyle, financial, and health factors. This trend is expected to continue. According to the 2020 Refractive Surgery Market Report, global demand for refractive surgical procedures (laser refractive surgery, presbyopia-correcting surgery, refractive lens exchange, and phakic IOL implantation) is expected to reach \$10.3 billion in total patient fees in 2025—up from \$6.5 billion in 2019. Annual surgical volume is predicted to grow from 3.6

million to 5.8 million procedures [57]. Ocular symptoms of COVID-19 have thus far proven to be mild but may be the only manifestation of the disease. Even after patients recover from a COVID-19 infection, they could be at higher risk for post-operative eye inflammation. The risk of spreading the virus via ocular secretions appears limited. Patient screening prior to the surgical evaluation, frequent surface disinfection, and slit lamp shields along with basic precautions in the clinic and operating room can help minimize any potential risk. There can be a role for teleophthalmology in the refractive surgery consultation and post-operative care. Along with ISBCS, these online visits can help increase efficiency when caring for these patients even after the pandemic.

## Declarations

**Human and Animal Rights** This article does not contain any studies with human or animal subjects performed by any of the authors.

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