Coronavirus disease 2019 (COVID-19) is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It was first identified in December 2019 in Wuhan, Hubei, China [1]. The World Health Organization (WHO) declared the COVID-19 outbreak as a pandemic on March 11, 2020. Since then it has infected millions of people around the globe. Fever, cough, fatigue, shortness of breath, and loss of smell and taste are the common symptoms of coronavirus infection [2–4]. While the majority of cases result in mild symptoms, some progress to acute respiratory distress syndrome (ARDS), multi-organ failure, septic shock, and other fatal complications [5, 6]. The time from exposure to onset of symptoms ranges from 2 to 14 days. The standard method of diagnosis is by real-time reverse transcription-polymerase chain reaction (r RT-PCR) from a nasopharyngeal swab [7]. There are no specific antiviral treatments for COVID-19 and the development of a vaccine is still under trial phase. Presently mainstream involves the treatment of symptoms, supportive care, isolation, and trial of different antibiotic combinations. Health care workers are the frontline workers in the fight against corona putting them as well as other patients they are treating at risk [8, 9]. As the percentage of SARS-CoV-2-positive cases increases, affected patients or asymptomatic carriers might frequently present to hospitals and clinics. When patients come to an ophthalmologist for ocular examination, they have direct contact with examination equipment. Therefore, strict modifications need to be taken up by ophthalmologists for clinical, diagnostic, and management of eye disorders to decrease the risk of transmission at their level.
distance between the patient and ophthalmologist. Clinical reports have suggested that tears act as a medium of infection. A case series by Loon et al. showed that viral RNA of the SARS-CoV can be detected by reverse-transcription polymerase chain reaction (RT-PCR) from the tears of infected individuals [15], thereby putting ophthalmologists at high risk as the ophthalmologists and instruments used by them come in contact with tears on a daily basis. Thus, it is essential to develop an efficient system of disinfection and personal protective equipment (PPE) protocols for the ophthalmology clinic.

The proximity of patients and doctors during an eye examination, the presence of tears and liquids for anesthesia and dilation, or the potential aerosol or droplets from “air puff” tonometry pose a high risk for transmission [16].

Conjunctivitis has been reported in 0.8–5.2% of COVID-19 patients [4, 17, 18]. Conjunctivitis is a common condition presenting in ophthalmic practice; thus, high vigilance is needed. Direct contact with the ocular surface and mucosal membrane during routine ophthalmic examination may have a risk of infection. Hypercoagulability is a major cause of complications in COVID-19 patients resulting from hyper-inflammatory response caused by the SARS-CoV-2 virus [19, 20]. Non-arteritic central retinal artery occlusion has been reported to occur due to the retinal artery being occluded from an atherosclerotic lesion or hypercoagulable state such as with COVID-19 [21].

43.3 General Modifications in the Practice of Ophthalmology: Steps to Decrease the Risk

The Health care system is facing unprecedented times and the only possible way out is reducing the transmission of the coronavirus by flattening the curve of disease transmission [22]. Several modifications have been adopted in the delivery of health care in order to protect the patients visiting hospitals and clinics for treatment. The safety of health care workers is also important for the delivery of uninterrupted services. Several guidelines have been provided and are being modified regularly to develop an efficient low-risk system. Following guidelines are being followed worldwide by ophthalmologists for safe clinical practice.

43.3.1 Triage System

Adopting a triage system of patients is an efficient way of assessing patients needing urgent care. Routine eye care services that can be managed by telemedicine should be discontinued and only emergency eye care services to be provided. Patients coming to an eye clinic are at risk of exposure to COVID-19 infection. Maximum patients attending for eye care belong to the geriatric population suffering from underlying chronic medical conditions such as diabetes and hypertension. Patients with comorbidities are at higher risk of developing complications after acquiring COVID-19 infection. Therefore, it is important to develop an efficient workable system of prioritization of patients needing eye care. Services should continue to be provided to the patients at high risk of visual loss without treatment. Following conditions can be considered as eye emergencies (American Academy of Ophthalmologists (AAO)) [23]:

- Exudative age-related macular degeneration
- Severe diabetic retinopathy
- Acute retinal detachment
- Advanced or rapidly progressive glaucoma
- Severe, active uveitis
- Serious ocular oncology conditions
- Retinopathy of prematurity (screening and treatment)
- Globe rupture or other significant trauma
- Serious ocular infections (microbial keratitis, endophthalmitis)

Triage should be done by trained personnel including an optometrist, ophthalmic technician, or ophthalmologist. Telephonic triaging should
be done where possible with respect to the emergency/nonemergency nature of the visit. Preliminary screening can be done regarding possible COVID-19 symptoms or history of contact before giving an appointment. If the condition is considered an emergency, the patient should be given a specific time to report to the clinic/hospital to avoid crowding.

43.3.2 Management of Patients at Eye Care Facility During COVID-19

Several steps need to be taken to provide efficient risk-free services at the level of eye care facility which can be divided into screening, examination, and treatment.

Screening

Every eye care center should set up an entry control and screening facility. Entry of children and the elderly (>65 years) into the hospital should not be encouraged unless they are patients themselves. Proper database should be prepared for all the patients visiting the eye care facility with all demographic details to be taken properly. Every patient should be made to fill a questionnaire prepared for screening everyone presenting at the eye care facility. The questionnaire should include history regarding symptoms that are cold, cough, fever, and respiratory distress, and diarrhea, loss of smell or acute conjunctivitis in patients or attendants or family members. Questions regarding recent travel, occupation, and contact with a COVID-19 patient or a suspected COVID-19 patient and/or their contacts should also be included. Body temperature screening with an infrared noncontact thermometer should be done at the point of entry. The patients and their attendants should wear masks provided and follow proper hand hygiene before entering the examination room with 70% alcohol-based sanitizers. Medical records of all the follow-up patients should be pulled out prior to the patient visit. The waiting area should be kept as empty as possible maintaining the norms of social distancing.

Examination

All possible efforts should be made to minimize patient contact time. Slit-lamp barriers (breath guards or breath shields) made from materials such as acetate sheets, clear plastic, or Perspex should be installed. The patient should also be informed not to speak during the examination and should be encouraged to properly wear the mask as the risk of droplet-based transmission increases during slit-lamp examination. Investigations should be done only if absolutely needed. All aerosol-based procedures including noncontact tonometer (NCT) which has shown to result in micro-aerosol production should be avoided [24, 25]. Use of Tonopen with a disposable tip or Goldmann applanation tonometry (with the cleaning of the applanation cone after every patient) is recommended if IOP measurement is necessary. Refraction can be performed using an autorefractor or a streak retinoscope where mandated. The trial frame and the metal rim of the lenses used should be cleaned with alcohol-based sanitizer after use. Contact lens trial, unless therapeutic, should be avoided. Surfaces and instruments should be cleaned between patients. All instruments and probes used in direct contact with the patient's tear film and ocular surface should be disinfected (using standard protocols) before reuse. For disinfecting 70–75% ethanol or isopropyl alcohol immediately should be used. Instruments having direct contact with the patient's ocular surface such as Goldmann applanation tonometer are disinfected by immersion in either 1:10 diluted bleach solution with sodium hypochlorite or 3% hydrogen peroxide for at least 5 min [26]. Hand hygiene should be performed regularly and after every patient using alcohol-based hand rubs as per the current recommendation by the Centre for Disease Control and Prevention and WHO.

Personal Protective Equipment (PPE) in the form of surgical caps, surgical scrub suits, triple-layer surgical masks/N95 masks, and gloves must be provided to the health care workers. The AAO has published a report advising ophthalmologists to wear masks and eye protection when examining patients potentially infected with COVID-19. Few reports have also suggested that when no eye
protection was worn, COVID-19 could be transmitted by aerosol contact with conjunctiva [27–29]. Chan et al. recommended the use of PPE for all cases regardless of COVID status, as well as hand hygiene measures and use of gloves, N95 masks, goggles, and gowns.

**Treatment**

Pharmacy services and optical dispensing should be available maintaining the distancing protocol. All surgeries must be day care unless the medical condition comes under mandatory admission. Defer all procedures and surgeries on a COVID-19 patient until the patient recovers, unless deferral of treatment by 2 weeks has a potential risk for loss of vision, eye, and life. If a procedure or a surgery is mandated, it should be performed in a multispeciality hospital approved for COVID-19 treatment and all the health care workers involved in the procedure/surgery should have full PPE. The role of hydroxyl-chloroquine prophylaxis is debatable but is being given to health care workers attending COVID-19 patients. Local anesthesia should be preferred over general anesthesia for performing surgeries. All universal precautions should be taken with minimum number of staff in the operation theater. Positive ventilation should be avoided in the operation theater during the procedure and for at least 20 min after the patient has left the theater. Protocol-based disinfection of the OT should be done after each surgical procedure (All India Ophthalmological Society—Indian Journal of Ophthalmology Expert Group for COVID-19 Practice Guidelines) [30].

43.4  **Modifications in Clinical and Surgical Practices in Retina During COVID Era**

43.4.1  **Special Challenges Faced**

Every specialty in ophthalmology is facing their own challenges during the COVID-19 pandemic. Retinal specialty is also facing unprecedented situations as avoiding close contact with the patient is very difficult during retinal examinations. Most of the retinal disorders are vision-threatening if not treated timely. Also, most of the ophthalmic emergencies fall under this specialty. The retina clinic has a large component of patients who are elderly and with comorbid diseases who are at higher risk of developing severe complications of COVID-19 infection. Thus, retinal specialists have a huge responsibility toward the patients as well as themselves and other health care workers.

43.4.2  **Retinal Emergency Care**

New measures are being taken in treating retina patients to reduce their exposure to each other and to the medical team. Patients with urgent sight-threatening conditions are being entertained and nonurgent patients are being deferred. Several guidelines are being made by international and national ophthalmic bodies to help retina specialists to provide emergency care by triage of patients. On the basis of the complaint of the patient, we can divide them into urgent, semi-urgent, and nonurgent [31]. Sudden or rapid vision loss, acute onset of flashes, recent onset of metamorphopsia and new cases of ocular tumor, retinopathy of prematurity (ROP), and retinoblastoma are included among urgent and should be promptly treated. Patients with diabetic retinopathy with slow onset of vision loss, exudative age-related macular degeneration, retinal vein occlusion or diabetic macular edema, and recently operated cases can be considered semi-urgent for which appointment can be scheduled. Patients with stable diabetic retinopathy of any stage, stable patients receiving anti-VEGF injections regularly for different indications, and stable post-surgery patients can be deferred.

The American Society of Retina Specialists (ASRS) released guidelines to help retina practices to reduce risk and assure the health and safety of patients during the COVID-19 pandemic. These guidelines were released in March 2020 defining essential visits for patients and categorizing patients into emergent, urgent, and
nonurgent, nonelective cases during the pandemic. For emergent surgical indications, the risk of permanent vision loss without early intervention is high whereas for urgent surgical indications, the risk of severe and permanent vision loss without immediate surgery is not as high and treatment can be delayed. Retinal surgeons should monitor urgent indications as they can become emergent, according to the ASRS press release. For nonurgent, nonelective patients, surgery can be delayed without significant risk to further vision. Retinal surgeons should follow nonurgent, nonelective patients, as their condition can worsen and urgency increase [32].

**Emergent surgical indications may include:**

- Acute retinal detachment—macula attached\(^1\)
- Acute retinal detachment—macula detached in a monocular patient (see Footnote 1)
- Retained lens fragments with elevated intraocular pressure not controlled medically
- Acute endophthalmitis with severe vision loss
- Open globe injury with or without an intraocular foreign body (see Footnote 1)
- Expulsive choroidal hemorrhage (see Footnote 1)
- Dense vitreous hemorrhage in monocular patient
- Exposed/infected scleral buckle or other ocular implants

**Urgent surgical indications may include**\(^2\):

- Retinal detachment—macula detached
- Retained lens fragment with medically controlled intraocular pressure
- Vitreous hemorrhage in which a retinal tear or detachment is suspected

**Nonurgent, nonelective surgical indications may include**\(^3\):

- Macular hole
- Dislocated intraocular implant lens
- Diabetic vitreous hemorrhage with no macula-threatening retinal detachment
- Retained silicone oil
- Macular epiretinal membrane/vitreomacular traction

### 43.4.3 Retinal Examination Protocols

The examination and treatment of retinal conditions are done face to face thus involving close contact between the patients and the practitioner. Thus, all the standard protocols mentioned earlier should be followed to minimize the risk of droplet transmission. Patients who are already on follow-ups should be advised home dilation to shorten their visit to the hospital as well as avoiding exposure of health care workers to tears while instilling the drops. Electronic prescriptions can be sent to patients for dilation keeping drug allergies in mind. Dilation of eye in retinal care set-up should be done wearing gloves and a face shield and proper hand hygiene to be followed after every patient. A non-touch technique can be used for putting drops by asking the patient to retract his lid or using disposable cotton-tipped applicator [31].

The use of slit lamp barriers should be done regularly and should be cleaned on regular basis. The retinal examination should be done strictly with an indirect ophthalmoscope and direct ophthalmoscopy and contact lens-based fundus examination should be avoided. Examination should be done using a face shield and protective goggles. The direction of gaze can be instructed by pointing in the direction or gentle tapping to avoid unwanted aerosol generation by talking to the patient. Cotton tipped applicator can be used as a scleral depressor for indentation while examining which should be ideally avoided until needed.

Infants undergoing screening for retinopathy must be placed on a crib with a plastic or polythene sheet covering exposing only the face, with the mother maintaining at least 2 m of distance.

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\(^1\) May be urgent depending on location and character.
\(^2\) These indications could be considered emergent if the patient is monocular or extenuating circumstances arise.
\(^3\) These indications could be considered urgent/emergent if the patient is monocular or extenuating circumstances arise.
The examiner screens the baby using indirect ophthalmoscopy or a retinal camera. The barrier sheet used for the crib is replaced or sanitized between successive infants (All India Ophthalmological Society—Indian Journal of Ophthalmology Expert Group for COVID-19 Practice Guidelines) [30].

Mask and PPE etiquette should be followed by all the attending doctors and health care workers. Protections for head, mouth, nose, and eye with a surgical cap, N95 masks, and goggles/face shield should be used by the examiner. Three-ply surgical masks should be worn by patients as well as their attendants. Strict hand hygiene should be followed by the health care workers as well as patients and their attendants using alcohol-based hand rub or by washing with soap and water (minimum 20 s). Clean surfaces and instruments between patients. Masks should be changed every 6 h or immediately when contaminated or wet. The CDC recommended the use of disinfectants specific to COVID-19, including diluted household bleach (five tablespoons of bleach per gallon of water) and alcohol solutions with at least 70% alcohol.

43.4.4 Diagnostic Procedures

Imaging services should be modified shortened imaging protocols in order to provide rapid and minimal contact. Investigations like OCT, OCTA should be ordered on the retina specialist’s discretion. OCT should be preferred as they are less time-consuming thus reducing the time of contact. Shared equipment such as the B-scan probes needs strict sterilization protocols as they come in contact with the eye of the patient, should be done when urgent need is there. Fundus Fluorescein Angiography (FFA) and Indocyanine Green Angiography (ICG) should be avoided, unless necessary as they are time taking procedures. All the essential Imaging devices should be placed in different rooms to avoid crowding. Protective shields and regular recommended cleaning of the devices should be done.

43.4.5 Medical Management of Retinal Cases

Several organizations have now produced general guidance for ophthalmologists on managing patients during the pandemic (AAO, ASRS, AIOS). Numerous challenges are being faced by retina specialists both in the field of medical and surgical retina.

43.4.5.1 Retinal Lasers

Retinal lasers to be done for urgent conditions only which includes active proliferative diabetic retinopathy (PDR), ROP, Retinal tears, or breaks (e.g., Horseshoe tears) and laser barrage in macula on RD, subclinical RD, and extrafoveal CNVM. Patients with stable vision and having diabetic macular edema or macular edema due to other causes can be deferred [31, 33–36].

43.4.5.2 Anti-vascular Endothelial Growth Factor (VEGF)

Anti-VEGF therapy is essential for the treatment of certain retinal disorders and has to be administered even monthly in few of them such as macular edema due to diabetic retinopathy, CRVO and exudative age related macular degeneration (AMD). Anti-VEGF therapy should be provided under a modified regimen. Each day different teams of injecting retina specialists and minimum possible paramedical staff should be present, teams scheduled on different days should not meet each other. The Royal College of Ophthalmologists has proposed the following guidelines for administration of anti-VEGF during COVID-19 [37].

Exudative Age-Related Macular Degeneration

For new cases, diagnosis should be confirmed with OCT and OCT-Angiography, if available. Confirmed new wet AMD cases should be treated with a loading phase of three injections of anti-VEGF and then continued on 8 weekly bases with no clinic review. For old cases, 8 weekly anti-VEGF therapy with no clinic review to be followed unless they mention a significant drop...
in vision at their injection visit. Such patients may need OCT and visual acuity assessments.

**Diabetic Macular Oedema**

Anti-VEGF injections can be deferred and can be reviewed in the clinic after 4 months. New cases of severe NPDR and active PDR should be treated with anti-VEGF agents and PRP. Virtual review with OCT and wide-field color photography is the preferred option for reviewing patients.

**Central Retinal Vein Occlusion (CRVO)**

For new patients with macular edema due to CRVO anti-VEGF treatment as per the protocol to be given whereas old patients who had adequately received injections should undergo PRP if needed to reduce the risk of rubeotic glaucoma. Branch retinal vein occlusion is not considered to be sight-threatening, so review can be differed for 4 months.

### 43.4.6 Indications for Surgery

All elective surgical procedures need to be deferred. Emergency indications have already been discussed for performing retinal surgeries. The American Society of Retinal Surgeons (ASRS) proposed procedures for emergent/urgent conditions enumerated in Table 43.1 [32]

Before operating on any patient they should undergo COVID-19 testing to confirm the status of the patient as per the local regulatory health protocol. All health care workers should follow PPE etiquette and minimal possible staff should be involved in surgical procedures. Donning and doffing areas to be made as per the protocols in the OT premises and proper sequence to be followed for doing the same. It is even advised to perform surgeries with all possible precautions irrespective of COVID-19 status. Topical anesthesia and local anesthesia should be preferred where possible. In patient preparation, draping should be done properly to avoid exposure to droplets and aerosols. Five percent povidone-iodine should be instilled in the conjunctival sac 5–10 min as it is virucidal and disinfects the ocular surface and conjunctival cul-de-sac in 15 s. The quickest possible surgical procedure should be performed by an experienced surgeon. Valved cannulas should be used for vitrectomies in order to minimize contact with ocular fluids. Diathermy to be used cautiously as leads to aerosol generation [38]. Vitrectomy should be preferred over scleral buckling. All the instruments, surfaces, and machinery should be properly sterilized following standard protocols. Operation theater should be fumigated regularly. All surgeries must be day care unless the medical conditions strictly mandate admission. If a COVID-19 positive patient is to be operated to salvage vision it should be done in a designated COVID-19 facility. All the health care workers involved in the procedure/surgery should have full PPE and possibly HCQ prophylaxis.

**Table 43.1** American Society of Retinal Surgeons (ASRS) proposed emergent/urgent indications and procedures to be performed

| Indication                                                                 | Procedure                                           |
|---------------------------------------------------------------------------|-----------------------------------------------------|
| Retinal detachment/trauma/intraocular infection/vitreous                   | Vitrectomy (MIVS)/scleral buckle                     |
| Hemorrhage/retinal tear/intraocular foreign body                          |                                                     |
| Proliferative diabetic retinopathy/proliferative                           | Membrane peeling/ILM peeling                        |
| Vitreoretinopathy/complex preretinal membrane/complex macular pathology or hole |                                                     |
| Lens complications acute                                                 | Pars plana lensctomy/phacoemulsification            |
| Trauma                                                                    | Repair open globe                                   |
| Pediatric/developmentally delayed evaluation (retinoblastoma, trauma, retinal detachment) | Examination under anesthesia (EUA)                   |
| Retinal detachment/retinal tear/trauma                                    | Laser indirect retinopexy—complex                   |
| Retinal detachment                                                        | Pneumatic retinopexy                                |
| Trauma/infection/intraocular malignancy                                   | Enucleation                                         |
| Intraocular malignancy                                                    | Ocular brachytherapy                                |
43.4.7 Screening

Early detection and timely treatment are very crucial in both exudative AMD as well as diabetic retinopathy which have been made possible by screening. Regular screening which is the key in both the conditions has become a challenge to retina specialists in the COVID era. Geriatric patients as well as diabetics both are at high risk of developing the COVID infection-related complications.

Age-Related Macular Degeneration Regular appointments of screening should be canceled. Patients should be asked to do home-based monitoring and should be guided to report on a marked drop in vision. Home-based monitoring may include the use of Amsler grid and appointments with specialists using telemedicine. The upcoming home-based remote monitoring on horizon is developing an artificial intelligence-enabled, home-based OCT system for patients with wet AMD [39].

Diabetic Retinopathy The main aim should be reducing the progression and severity of diabetic retinopathy which could be done by controlling the modifiable risk factors like glycemic status and blood pressure. Telemedicine is also an important tool as remote imaging of the fundus can be analyzed by a team of specialists and the course of treatment can be decided upon [40]. Lund et al. recommend that patients who have stable diabetic retinopathy with no urgent or referable indication can have retinal screening at 18–24 months interval during the COVID-19 pandemic [41].

43.4.8 Special Considerations

Intraocular Tumors and Ocular Metastasis As these are vision as well as life-threatening conditions their treatment should continue with all possible precautions. Interdisciplinary cooperation is needed to have all possible investigations and imaging done beforehand and video consultation to be done in order to avoid patients visiting time. Systemic chemotherapy should be continued for intraocular Lymphoma and ocular metastasis. External beam radiation therapy should be preferred. Retinoblastoma treatment for old and new cases should continue as before.

Pediatric Retina Examination of children is a challenge as it is difficult for them to follow precautions like wearing masks and hand hygiene putting both them and health care workers at risk. Special precautions like allowing only a single attendant and distancing protocol should be the mainstay of avoiding infection. For ROP which requires immediate care, the Indian Retinopathy of Prematurity (iROP) Society has formulated guidelines in March 2020 which has been summarized in Table 43.2 [42].

| Findings                      | Follow-up and treatment                      |
|-------------------------------|----------------------------------------------|
| Immature retina in zone 3 and 2 and zone 3–4 weeks or more  |
| ROP in zone 3 and zone 2 anterior | 3–4 weeks                                  |
| ROP in zone 2 posterior | 2 weeks                                     |
| ROP in zone 1 | Urgent/less than a week/treat-laser if disease is amenable. Intravitreal injections can be used but caution to be exercised since follow-up. |
| Pre-plus | Consider early treatment or early follow-up if the pupil does not dilate well and the media is not clear. |
| Pre-plus | With good pupillary dilatation and clear media and other low-risk features delay the next screening by an additional 1 week from the current guidelines. |
| Stage 4A and 4B ROP | Surgery must be performed as soon as the treating ROP specialist feels it is required with adequate precautions taken while providing anesthesia as per prescribed guidelines. |
| Stage 5 ROP | Surgery is not urgent. Case-to-case based decision must be considered. |
43 Telemedicine

HK Li first described the use of telemedicine in ophthalmology in 1999 [43]. Telemedicine is defined as the use of information technologies to support health care between participants who are separated from each other. It characterizes a combination of medical expertise and recent technology that delivers medical services over distance. The current new-age technology is well equipped with video-equipped computers, high-resolution cell phone cameras, and fast broadband internet service.

The fight against the COVID 19 virus appears to be a long one and social distancing seems to be the only possible way to flatten the disease curve. Telemedicine can prove to be an apt tool to not only triage the patients needing immediate care but also providing health care inside a safe home environment. Telemedicine provides an opportunity to ophthalmologists in performing their professional responsibilities without being the foci of disease transmission. Telemedicine practice should be widely advertised on social media and other platforms.

43.6 Conclusion

Retina specialists like all other frontline health workers in this COVID era should embrace the present scenario and should move ahead by providing safe and practical eye care services in these unprecedented times. Retinal practice has to follow the new normal. From the above discussion, we can summarize the steps which need to be taken to combat with the easing of the curbs in ever-increasing rate of infection. To begin with, teleconsultation needs to be accepted as the new normal and regular way of reaching out to the patients. As there is a restriction in the number of patients visiting the eye care clinics, we have to increase the working hours so that patients can be provided regular care following all the possible precautions. The cost of PPE and other sanitization measures has to become a part of regular expenditure of hospital establishments. Online training of the residents should also become a part of the new normal.

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