Adoption of newer teaching methods to overcome challenges of training in ophthalmology residency during the COVID-19 pandemic

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The coronavirus disease 2019 (COVID-19) pandemic has disrupted training programs across all specialties. Surgical specialties, such as ophthalmology, that need continued microsurgical training are affected the most. The pandemic has resulted in ophthalmology residents being taken off their regular duties in ophthalmology and inducted into COVID duties. The focus on COVID care has de-emphasized training in ophthalmology. We highlight the challenges that teachers face in continuing the training programs of theory, clinical skill, and surgical skill transfer. Embracing technology is the need of the hour. We discuss the multiple options available to enable continued training programs and emphasize the need for all training institutes to include technology as an additional component of their training curricula.

Key words: COVID 19 pandemic, newer, ophthalmology residency, teaching methods, training

The coronavirus disease 2019 (COVID-19) pandemic has posed challenges to various fields of medicine, and one such challenge is the continued training of residents in many specialties, more so in surgical specialties, and ophthalmology is not exempt from it.[1] The evolving pandemic brought in a paradigm shift in the clinical landscape. In the previous year, when the pandemic was raging, the emphasis was on COVID care. Residents and consultants from other specialties were inducted into COVID duties. Also, the number of patients attending the ophthalmology outpatient department (OPD) and opting for elective surgeries had drastically reduced. Due to the pandemic, the government had imposed closure of higher education institutes, including medical schools, and had banned medical undergraduate students from patient contact.[2] The emphasis also shifted toward telemedicine and teleconsultation.[3]

Ophthalmology is a field that requires close contact with patients during examination and hence to protect the health care workers, ophthalmology associations all over the world came out with advisories to limit ocular examination to emergency conditions.[4] It had been suggested that experienced faculty attend to patients at the OPD and operation theatres, to reduce patient exposure time.[5] This had been advised because residents lack the knowledge, skills, and clinical experience, and hence spend a longer time examining each patient and thus are susceptible to increased risk of infection. Therefore, the training of residents was compromised.[6] Microsurgical training requires a continued ongoing program so that residents do not lose out on valuable time and can acquire requisite basic skills during residency. The COVID-19 pandemic, which started in March 2020 in India, and the ensuing nationwide lockdown for 2 months disrupted the academic training. The residents lost out on nearly 6 months of training. Thus, we need to explore alternative teaching methods to continue resident education. If any such situation arises in future, we need to be prepared with newer teaching methods to ensure undisrupted training.

Limitations of Traditional Training During COVID-19 Pandemic

Ophthalmology surgical training in India has been largely dependent on outreach screening eye camps, and with the onset of COVID-19, these camps had been put on hold by the government in order to restrict nonessential movement in a bid to reduce the spread of infection.[7] Patient footfall to the ophthalmology OPD also reduced, thus affecting the ongoing training programs of the residents. Most medical colleges were recognized by the government as COVID hospitals thus disrupting all non-COVID care.[8] The faculty and residents of specialties such as ophthalmology had been inducted into COVID duties, and hence the training in the subject of ophthalmology was also affected.[9] This has been recognized by a survey conducted by Mishra *et al.* where 80.7% of the respondents expressed that COVID-19 had negatively impacted

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their surgical training.[10] For the first time, it was seen that the exit examinations of ophthalmology residents were conducted with virtual patients and clinical case scenarios, and the students were evaluated based on their knowledge of clinical skills and not on demonstration of skills.[11]

We endeavor to review the current methods of training, the challenges faced, and the newer methods available to ensure continued education of the residents. We discuss the various technologies available to achieve the same. The newer methods may help us bridge the gap in training.

Evolution of Ophthalmology Training Worldwide

Halsted's apprenticeship training, which was introduced in the late 19th century, encompassed the principles of training of residents under the supervision of a skilled surgical teacher and the attainment of skills based on sound scientific knowledge. The resident was allowed graded responsibility and independence in managing conditions of increasing complexity.[12] In the middle of the 20th century, various medical education boards were established, and they emphasized on quality rather than quantity. During this time, outcome-based evaluation of residents was introduced mostly in the United States and European countries.[13] The 21st century brought with it a new arm to surgery – technology, which needed to be incorporated into education policies. Along with this, was the need for increased documentation, which became integral to any residency program. Hence the efficiency of training became important. Wet lab training and simulation training were initiated. This change was ushered in, so that patient safety could be ensured, and operating times could be reduced. Therefore, residents acquired certain basic skills in controlled laboratory settings before they could operate on patients. This applies to ophthalmology training too, which is a microsurgical specialty and requires much more training in a laboratory setting before patient treatment.[14]

Ophthalmology training in India still follows the apprenticeship method of training. Thomas and Dogra surveyed the satisfaction levels among ophthalmology residents and found that 89.1% were satisfied with knowledge transfer during residency. However, they also stressed the need for exposure to core diagnostic techniques. Besides, they suggested that wet lab facilities be included in the curriculum.[15] World over, training of residents has shifted toward the objective assessment of proficiency. Establishment of simulation labs and wet labs in medical schools is mandatory in Western countries. In India, not all medical colleges provide wet lab training. The National Medical Commission of India also has not made wet lab training compulsory. The curriculum too is not uniform throughout India, and not many universities provide their curriculum on their websites thus indicating the lack of transparency that has been recognized by Grover *et al.* in their recommendations for a national curriculum for ophthalmology training.[16] The case volume approach adopted in teaching ophthalmology residents has to be replaced with objective structured training methods that will prepare the resident outside the operating room. It is also important to incorporate feedback and formative assessment.[17] Honavar has suggested that judicious use of resources and standardization of residency programs across the country is the need of the hour and a

system-based approach needs to be adopted for improving the quality of ophthalmology training in India.[18] Grover *et al.* have emphasized incorporating practice-based learning, interpersonal skills, and communication, system-based approach, and professionalism. They have provided various teaching methods that can be adopted by teaching institutes.[16] They suggest wet lab training to be used for learning special and complicated procedures. The usefulness of wet lab training needs to be highlighted not only to learn complicated procedures but also to learn the basics of surgery to be able to improve the quality of residents as shown by Ramani *et al.* in their study.[19]

Ajay *et al.* in their survey of all the final-year residents found that most residents perceived the wet lab training as an important aspect of their training and also stressed the need for demonstration of clinical skills.[20] The COVID-19 pandemic has exposed some weaknesses in our present system, and we need to recognize our limitations. Novel and objective methods of teaching should be adopted so that we are better prepared in case of any such future pandemics. Table 1 depicts the newer teaching methods that can be adopted to teach various skills.

Fig. 1 demonstrates the decision tress for planning training of the residents during COVID-19.

Newer Teaching Methods

Theoretical Knowledge transfer

1. **Didactic lectures**: With the emergence of the new term *social distancing*, many teaching programs, including didactic lectures, journal clubs, and case presentations, which help the resident acquire knowledge through discussion of the subject have taken a backseat. These programs can continue with the use of technology. There are various interactive platforms (Zoom, Cisco Webex), by which effective student and teacher interaction can occur. These programs can become a very good substitute for physical classes, and the training programs can continue without any interruption.
   Chen *et al.* have suggested that with collaboration they developed a citywide core education curriculum for the New York areas, and focused subspecialty talks were given by faculty from different institutions.[21] Murdock and coworkers also suggest a multi-institutional virtual morning report where residents present cases, and discussion occurs with a clinical educator facilitator. This method was useful in establishing good clinical reasoning.[22] Thus, this emphasizes that at times such as these, institutions must come together to continue education through didactic lectures that can be made available to a wider audience through teleconferencing.[16]
2. **Consultant case presentation:** Here the consultants present a case and discuss the various differential diagnosis and how they reach a diagnosis. This teaching method helps in understanding interesting and complex problems. It enlightens residents about the thought process when a case is examined and ensures a better understanding of the approach toward any case.[16]
3. **Use of mobile devices to integrate curricular material**: Leydon and Schwartz showed the efficacy of using mobile technology in undergraduate medical teaching. They used an iPad mini with an integrated curriculum and electronic hospital record

Table 1: The various teaching methods

I. Theoretical Knowledge Transfer	II. Clinical Skills Training	III. Surgical Training

Didactic lectures. Case presentation	1. Video demonstrations	1. Virtual reality training
		   a. Eyesi Simulator
		   b. HelpMeSee simulator for MSICS

Consultant case presentation	2. Student volunteers	2. Dry lab training
Use of mobile devices to integrate curricular material	3. Use of mannequins: Simulator Direct and indirect ophthalmoscopy	3. Wet lab training
4. Social media	4. Artificial model eyes: Slit lamp examination, goinioscopy, retinoscopy	4. Videos to learn surgeries

E-Learning modules
   a. Platforms such as MOOC/MOODLE
   b. Computer-assisted learning ophthalmology program
   c. Case-based e-learning modules
   d. Active e-learning live webinars
   e. Three-dimensional animated programs
   f. Virtual mentor cataract training platform		

6. Resident as teacher		

MOOC=Massive Open Online Course; MOODLE=Modular Object-Oriented Dynamic Learning Environment; MSICS=Manual small incision cataract surgery
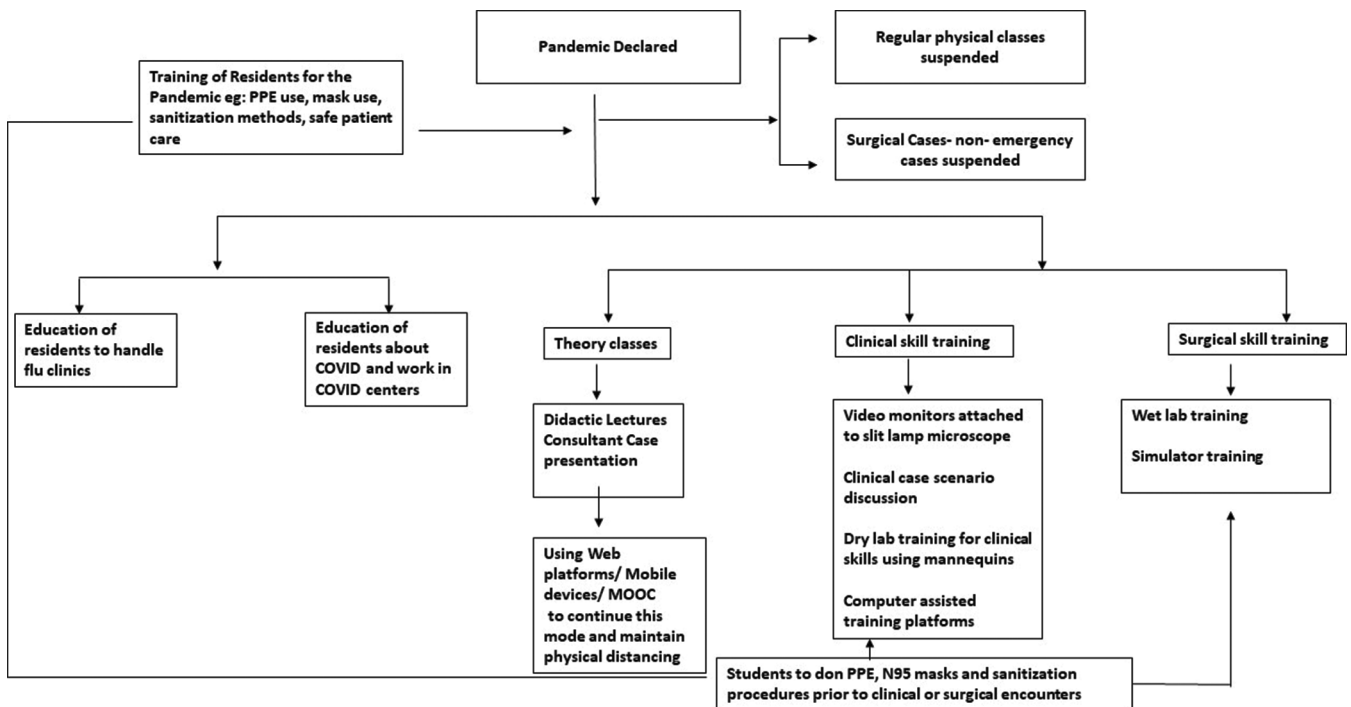

Figure 1: Decision tree for planning the residency training program

system. This enabled easy access to e-books and augmented reality. It was seen that 92% of the respondents found this system of education successful.[23] These technologies can be used not only in clerkship but also for medical students who can be given access to the curriculum, PowerPoint presentations, or keynote presentations that would make teaching more effective.

4. **Social media** (platforms such as WhatsApp, Twitter, Facebook, Telegram, YouTube): Coleman and O'Connor have analyzed the usefulness of WhatsApp in medical teaching in their review and identified three strategies of WhatsApp use: (1) purely educational use with a predefined curriculum, (2) primarily educational use without curriculum, and (3) noneducational use. They found that improvement of learner's knowledge followed by WhatsApp learning was good in most of the studies.[24] WhatsApp has the advantage of being an informal platform, with real-time interaction. Social media platforms help in collaborative learning, assessment, and experience sharing. They, however, have the disadvantages of lack of privacy, addiction, cyberbullying, and less effective training.[25] The advantage of using these platforms is that they are popular and convenient and if judiciously used can be a very efficient medical learning tool.

5. **E-learning modules**:
   a. **Platforms such as Massive Open Online Course (MOOC) or Modular Object-Oriented Dynamic Learning Environment (MOODLE):** These are extensively used in undergraduate courses and specialty courses that can be effectively used for knowledge transfer for ophthalmology residents. The residents can learn at their own pace as this is not time bound. These platforms can also be used for skill training and cognitive training.[26] Many models have been enumerated by Lee *et al.* in their review, and their validity also has been proven.[12]
   b. **Computer-assisted learning ophthalmology program:** Kaufmann and Lee developed a computer-assisted ophthalmology program for pupillary reflexes. It was shown to be very effective but not widely used.[27] A computer with mannequin heads housing two motor-driven camera diaphragms that simulate pupillary responses is used. This shows promise where we can have residents learning clinical skills and examination techniques using these methods. This needs to be expanded to include other clinical skills for ophthalmology.
   c. **Case-based e-learning modules:** This method follows a presentation of a case and multiple scenarios that can ensue in the management of the case. This is a very useful method to teach both common and rare conditions. This method helps the teacher analyze the thinking of the resident, and it is valuable in guiding the thought process in the required direction, thus helping in adequate knowledge transfer. Stahl *et al.* showed its usefulness in undergraduate students, but it is a viable option to be included in the residents training program to make it effective for ophthalmology residents.[28]
   d. **Active e-learning through live webinars**: Romano *et al.* in their study conducted a web-based course of vitreoretinal surgeries. They compared on-site participants with virtual participants in terms of satisfaction, interaction, and learning effectiveness. They found no difference between the groups, thus establishing the use of webinars as a mode of knowledge transfer for theory or skill transfer.[29]
   e. **Three-dimensional animated programs**: These programs developed for learning cataract surgery by the Vienna Medical School have shown an improved understanding by the students in a randomized control trial.[30] Here surgical videos, accompanied by three-dimensional animated videos of the same procedures, were shown to students. Analysis of students post this training method showed that students outperformed their counterparts in both theoretical knowledge and topographical understanding. It was seen that programs such as these evaluate the residents' understanding of each surgical step, thus enhancing their critical thinking.
   f. **Virtual mentor cataract training platform**: This is a platform that helps students learn nontechnical skills such as cognitive skills in surgery via a computer-based assessment and feedback questions.[31] It is an interactive computer-based program for teaching cognitive aspects of hydrodissection, including performance and decision making. This study provided good internal validity in assessing students' understanding and performance. This model can be extrapolated to include other clinical and surgical skills.

6. **Resident as teacher:** Inclusion of residents in the training of the medical undergraduate students or junior residents will enhance their understanding of the subjects. This method can be used as a training method as it increases their awareness of the subject and the teaching methods. Chee *et al.* demonstrated the usefulness of this teaching method in ophthalmology residents and have suggested it to be included as part of the curriculum for ophthalmology residents.[32] Kumar and Agarwal also showed in their report that this method of teaching improved academic performance.[32]

Clinical Skills Training

A large part of the skill training happens when the resident works in the OPD with the clinician. They learn by observing the faculty performing procedures, and they themselves perform procedures under supervision. This is going to be a challenge, as patient footfall is inconsistent and those who attend the OPD have to be treated with care so that there is minimal exposure to all the staff present in the OPD. Slit lamps that are connected to video monitors would provide students an opportunity to have a hands-on clinical experience. Cognitive task analysis can also be enabled by using technology. This has been demonstrated in other specialties such as orthopedics, and they can be explored to be included in ophthalmology skill training.[33]

1. **Video demonstrations**: Video demonstrations are a good alternative to on-site demonstrations.[34] The teachers should record videos highlighting each step of the clinical skill along with a step-by-step narrative, thus aiding skill transfer. In this digital age, short videos of each clinical skill that the resident can watch from anywhere can help in the training in basic clinical skills.

2. **Student volunteers**: Student volunteers can be used to teach and demonstrate clinical skills. Residents can perform procedures on each other to learn these skills and demonstrate. However, this needs to be explored with caution as residents and volunteers need to follow hand hygiene and have to use appropriate personal protective equipment for examination.[35]

3. **Use of mannequins**: Simulators are as good as actors in training in disasters.[36] This can be adopted to train residents in clinical skills. Mannequins with slides of fundus images being placed in the viewer slots and a direct ophthalmoscope can be used to train residents in basic fundus examination skills (EYE Exam Simulator, Kyoto Kagaku Co.).[37] The advantage of a laboratory setting, lack of exposure to patients, and the possibility of sterilizing the mannequins before the next resident use offer the best possible option at present. These mannequins are less expensive, whereas the other models such as the Eyesi direct and indirect ophthalmoscope are more expensive. However, studies have demonstrated that students trained in these systems had a better objective structured clinical examination score compared with students trained traditionally.[12]

4. **Artificial model eyes:** For slit lamp examination, retinoscopy, gonioscopy, and fundus examination artificial model eyes are available, and training institutes need to be equipped with them to ensure there is a continuum of the training process (Kashika Enterprise, Indore; SMR Ophthalmic Limited, Mumbai; and Gulden Ophthalmics, Pennsylvania, USA).[12]

Surgical Training

With the reduction in ophthalmology services during the COVID19 pandemic and limiting of nonemergency surgeries, cataract cases have reduced in training institutes. The only way to overcome this situation and to continue teaching surgical skills is to explore other methods of surgical teaching such as simulators and wet lab training.[21,38]

Patient training may take a while to start but a well-established wet lab can provide a continuum in the training with goat's eyes or simulators. Cadaver labs will ensure that the residents learn procedures other than cataract surgery such as dacryocystorhinostomy, lid surgeries, orbit, and strabismus surgeries. This will ensure that they attain the basic skills that need to be learned by a trained ophthalmologist during his or her residency.

1. **Virtual reality training:** There are many systems of which Eyesi Surgical has been widely used and studied for its efficacy. Eyesi Surgical is a reality simulator that helps one practice intraocular procedures. It consists of a mannequin with a model eye housed within it, which is attached to a computer interface and operating microscope. It contains internal sensors that track the movement of surgical instruments and the surgeon's hands. The software includes various training modules for cataract and vitreoretinal surgeries, and it provides performance metrics and feedback for the trainees.

   Various studies have shown the efficacy of this system by demonstrating a significant improvement in the surgical skills of residents, such as performing capsulorhexis in the wet lab or the operating room after training by Eyesi.[39,40] Ferris et al. have also shown that the introduction of Eyesi into the curriculum of U.K. residents showed a significant reduction in complications during cataract surgery from 4.2% to 2.6%. Virtual simulator training has been shown to reduce the mean phaco time, phaco power used, and the intraoperative complications. Also, it is shown to flatten the learning curve.

   In India, where maximum training is focused on manual small incision cataract surgery (MSICS) training, the HelpMeSee (HMS) eye surgery simulator seems promising.[41] The HMS simulator supports training in MSICS, and the content validity of this simulator has been demonstrated. This is an option that training institutes can consider investing to train residents using these models as it improves the safety of patients. Besides, in case of future pandemics, institutes will be better prepared to continue education by reducing dependence on patients.

2. **Dry lab training**: There are many simulators for various diagnostic techniques and surgeries. For cataract surgery, Abellán et al. have described a low-cost cataract surgery simulator. They conducted a randomized controlled trial that showed that those who were trained on the simulator achieved a higher percentage of satisfactory capsulorhexis compared with those without access to this training.[42] There are various other simulators for surgeries such as strabismus, oculoplasty, vitreoretinal surgeries, and trauma-related surgery. These need an initial capital investment, but the training of multiple residents makes it cost-effective over time.

3. **Wet lab training**: A wet lab with the availability of goat's eyes, pig's eyes, or artificial eyes has a far-reaching effect on the development of hand–eye coordination, confidence, and acquisition of basic skills. This gets transmitted into reduced complications during cataract surgery performed by residents. In a study conducted in our center, we demonstrated that the posterior capsule rent rates of cataract surgeries performed by residents showed a statistically significant reduction (6.9%) after wet lab training was introduced compared with those performed by residents without wet lab training (14.1%).[19] Many studies have evaluated and proved the efficacy of wet lab training in reducing the complications in resident-performed cataract surgeries in both phacoemulsification and small incision cataract surgery.[14] These studies only emphasize the need to incorporate these methods in training so that we are less dependent on patient footfall for the training of surgical skills. The wet lab could also be useful in training residents to perform surgeries such as trabeculectomy and keratoplasty.

4. **Videos to learn surgeries:** There are various social media platforms such as Telegram and WhatsApp that have surgical groups. Here consultants post their videos with narratives. These platforms help the resident as increased viewing of surgical videos enhances their creativity. Furthermore, watching various techniques aid them during their surgeries. This is because they are attuned to various surgical scenarios and hence can respond accurately and on time.

Training of faculty: The use of technology is promising, but the important aspect to make this effective is to train the faculty in these newer modalities. Their acceptance and application of new technology have a huge role to play in implementing the newer teaching methods. The success of these methods depends on integration to the existing teaching methods, student engagement, faculty acceptance, and administrative support.

Conclusion

We have outlined a few methods and techniques of resident training. Most of these methods, especially the simulators and wet lab training, have demonstrated good internal and external validity.

The need of the hour is to include newer teaching methods in the curriculum and maximally use them for the benefit of students. We need to be future-ready and embrace technology in training as we may be plagued with such pandemics in the future. Ophthalmology training institutes need to upgrade and include technology into their armamentarium of teaching so that we can continue educating residents uninterrupted.

Conflicts of interest
There are no conflicts of interest.

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