

## Impact of COVID-19 related national lockdown on care of corneal transplantation patients at a tertiary eye care centre in India

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**Purpose:** To study impact of COVID-19 related national lockdown on care of corneal transplantation patients at a tertiary eye centre in Andhra Pradesh state of South India. **Methods:** Cross-sectional questionnaire-based study conducted at tertiary eye care centre in Andhra Pradesh state of South India, included 109 patients who underwent keratoplasty (full thickness or partial thickness) at our centre and who came for follow-up visit after lockdown. Factors such as type, indication, number of keratoplasties in the operated eye, and unusual clinical outcomes identified during visit after the lockdown, were studied. Uncorrected visual acuity, best corrected visual acuity, clarity of graft, graft-host junction apposition, intactness of sutures, intraocular pressure and disc status were compared on visits made before and after lockdown. **Results:** During lockdown, 77.1% patients were properly using medications that was significantly ( $P = 0.0003$ ) lower than that of before the lockdown (90.8%). After the lockdown, 82.3% patients were using medications properly that was comparable ( $P = 0.11$ ) to that of during the lockdown (77.1%). The proportion of eyes with clear grafts and intact sutures decreased significantly after lockdown. The unusual outcomes observed after the lockdown were graft failure (36.7%), graft edema (11%), graft infiltrate (5.5%), phthisis bulbi (1.85%) and edematous graft cleared in eyes 3.7% eyes. **Conclusion:** We noted significant drop in usage of medications from 91% before lockdown to 77% during lockdown and maintained at 83% after lockdown. Edematous grafts increased from 41% before lockdown to 54% after the lockdown. Intactness of sutures decreased from 82% before lockdown to 69% after lockdown.

**Key words:** Corneal transplantation, COVID-19, edematous grafts, national lockdown, questionnaire-based study

An outbreak of a novel coronavirus disease (COVID-19) emerged in Wuhan, China in December 2019, and has quickly spread throughout the world. COVID-19 is a highly contagious disease which may progress to acute respiratory distress syndrome and even death. The infectious agent of this disease entity is a novel beta coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS CoV-2).<sup>[1]</sup> In less than 4 months, the outbreak has evolved rapidly from a World Health Organization Public Health Emergency of International Concern to formal declaration as a pandemic on March 11, 2020.<sup>[2]</sup>

COVID-19 has emerged to be the metaphoric Black Swan of the 21<sup>st</sup> century – an unexpected event of large magnitude and repercussion that has completely changed our way of

living.<sup>[3]</sup> The Government of India imposed a countrywide total lockdown of all non-essential services aiming towards restraining the quick spread of the disease. The first four phases of this lockdown extended from March 23 to April 14, 2020, from April 15 to May 3, 2020, from May 4 to May 17, 2020 and from May 18 to May 31, 2020 respectively.<sup>[4]</sup> The policy of social distancing for preventing the extent and spread of disease has crippled the ability of hospitals to deal with the large number of patients.<sup>[3]</sup> The delay in reaching the hospital due to the lockdown and terror of infection can lead to progression of the disease, further intensifying the difficulties. There is a need to halt delays in approaching hospital care and to increase provision of high-quality care by health-care workers.<sup>[5]</sup>

This is the first study in literature where we evaluated impact of COVID-19 related lockdown on care of patients who underwent corneal transplantation at a tertiary eye centre in Andhra Pradesh state of South India.

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## Methods

It was cross-sectional questionnaire-based study conducted at a tertiary eye centre in Andhra Pradesh state of South India. The study was performed after obtaining an approval from the Institutional Ethical Committee and it adhered to the tenets of the Declaration of Helsinki. As per the standard protocol of our hospital, all patients had previously given written informed consent for examination and for all medical records to be used for approved research projects. A consent to publish findings and images gathered from the patient (s) was also obtained from all participants of the study.

All the guidelines and precautions advised by All India Ophthalmological Society (AIOS) were strictly followed by all healthcare workers (HCWs) at all times. At our hospital, information posters and awareness messages were set up. Triage and screening of patients at the front desk were performed in accordance with the government guidelines. Overcrowding in waiting halls was controlled by reducing the number of attendants with the patients to one each. International patients were guided to reschedule their appointments by 4-6 weeks. The hospital staff was counselled to use protective measures and maintain personal hygiene. HCWs having cough, fever, malaise etc., were asked to stay at home and seek medical care.<sup>[6]</sup>

A total number of 109 patients who underwent keratoplasties (full thickness or partial thickness) at our centre since its inception in 2011 and who came for follow-up after the lockdown were involved in the study. Normally, we follow up keratoplasty patients on post-operative day 1, post-operative 1-week, post-operative 1 month and every 3 months for the first year and every 6 months after that duration. Comprehensive eye examination and necessary investigations in the follow-up visit were performed in all of these patients.

Data of all these patients were evaluated with the help of electronic medical record (EMR). Factors studied were type, indications and number of keratoplasties in operated eye, duration between surgery and last visit before the lockdown and unusual outcomes (if any) in visit after the lockdown. Uncorrected visual acuity (UCVA), best corrected visual acuity (BCVA), clarity of the graft, graft-host junction (GHJ) apposition, intactness of sutures, intraocular pressure (IOP) and disc status were compared on visits before and after the lockdown.

After explaining the purpose of the study, research requirements and procedures, consent to participate in the study was obtained verbally. Participation involved answering a questionnaire about their ocular clinical history, regularity of follow-ups in the past, the impact of the lockdown on care and availability and usage of medications during the lockdown. We tried to understand whether a detailed in-person examination was needed for the evaluation of these patients or a tele-consultation was sufficient. We also enquired about per capita per month income and any economic losses during the lockdown for better understanding the effect of the socioeconomic status on regularity of follow ups, usage of medications and care of patients. In the same questionnaire about the lockdown, we asked patients about consultations with other doctors, vision related problems, appearance of any new opacities in the operated eye, history of any ocular

trauma, history of any surgery on operated eye and other systemic problems during the lockdown. Few questions checking mental status of the patient during the lockdown were also asked.

The statistical analysis was done with the help of the software STATA v14.2 (StataCorp, College Station, TX, USA). Categorical data were described in proportions and compared between the visits using McNemar test. Continuous data were checked for the normality of distribution by Shapiro-Wilk test and, since all were of non-normal distribution, were described in median and inter-quartile range (IQR) and compared between the visits by Wilcoxon signed-rank test. A *P* value of <0.05 was considered as statistically significant.

## Results

We included a total of 109 eyes of 109 patients in the study. Median age of patients was 55 years (IQR, 44-64 years). Seventy-six (69.7%) patients were male while 33 (30.3%) were female. Forty-one patients (37.6%) were able to pay for their healthcare services while 68 (62.4%) were provided service free of cost and these numbers did not change in the post-COVID-19 duration. Majority of the patients came from rural areas (82 patients, 75.2%) while urban constituted the rest. The median distance from the hospital to the patient's home was 76 kilometres (IQR, 45-140 km). Overall, median per capita monthly income was INR 6000 (IQR, INR 2500-10000) off which rural population had median per capita monthly income of INR 3200 and urban population had median per capita monthly income of INR 9000.

The most common type of corneal transplantation was optical penetrating keratoplasty (45 eyes, 41.3%) followed by Descemet's stripping automated endothelial keratoplasty (30 eyes, 27.5%), therapeutic penetrating keratoplasty (28 eyes, 25.7%), Descemet's membrane endothelial keratoplasty (4 eyes, 3.7%) and deep anterior lamellar keratoplasty (2 eyes, 1.8%). The keratoplasty was combined with another procedure in 22 eyes (20.2%). The indications of keratoplasty were aphakic bullous keratopathy (4 eyes, 3.7%), endophthalmitis (6 eyes, 5.5%), failed graft (24 eyes, 22%), infectious keratitis (24 eyes, 22%), keratoconus (2 eyes, 1.8%), leucomatous scar (21 eyes, 19.3%), pseudophakic bullous keratopathy (22 eyes, 20.2%), recurrence (2 eyes, 1.8%) and others (4 eyes, 3.7%). Median number of total corneal transplants in operated eyes was 1 (IQR, 1-2). Post-operative complications after surgery (which was done before lockdown) were noted in 18 eyes (16.5%).

A total of 99 patients (90.8%) followed-up regularly and were using medications properly before the lockdown according to information gathered by a questionnaire provided to patients. Median duration from surgery to the visit before the lockdown was 3.8 months (IQR, 1.3-6.7 months). Table 1 summarizes the clinical details before and after the lockdown. During the lockdown, 84 patients (77.1%) were using medications properly that was significantly ( $p = 0.0003$ ) lower than that of before the lockdown (90.8%). The reasons (when assessed) for not using medications properly were inability to buy medicines in hospital (9 patients, 36%), non-availability of medicines locally (7 patients, 28%), stopping on own (6 patients, 24%), inability to afford (2 patients, 8%) and inappropriate dosage (1 patient, 4%).

**Table 1: Clinical Details of Corneal Transplant Patients Before and After the COVID-19 Lockdown**

Parameter		Before lockdown	After lockdown	P
BCVA	PL/PR/NPL	8 (7.3%)	12 (11%)	0.39
	logMAR, median (IQR)	1.30 (0.60-2.78)	1.30 (0.60-2.78)	0.18
Clear graft		65 (59.6%)	50 (45.9%)	0.004
Attached lenticule		34/34 (100%)	31/33 (93.9%)	0.50
Intact sutures		89 (82.4%)	75 (69.4%)	0.01
Well-apposed GHJ		92/94 (97.9%)	94/95 (99%)	1.00
Normal IOP		102 (93.4%)	103 (94.5%)	1.00
Healthy optic disc		68/79 (86.1%)	57/67 (85.1%)	1.00

BCVA: Best corrected visual acuity; GHJ: Graft host junction; IOP: Intraocular pressure; IQR: Inter-quartile range; PL/PR: Perception of light and projection of rays; NPL: No perception of light

**Table 2: The Results of Questionnaire Administered to Evaluate the Impact of Lockdown on Patients Who Underwent Corneal Transplantations**

Teleconsultation	82 patients (75.2%)
Satisfactory teleconsultation	77/82 patients (93.9%)
Consultation with doctor elsewhere	11 patients (10.1%)
Vision-related problem	53 patients (48.6%)
Opacity	30 eyes (27.5%)
History of ocular trauma	4 patients (3.7%)
Any surgery on the study eye	2 eyes (1.8%)
Other systemic problem	18 patients (16.5%)
Does the patient think loss of follow-up during lockdown caused the problem?	88 patients (80.7%)
Does the patient feel stressed because of the inability to come for follow-up during lockdown?	96 patients (88.1%)
Economic loss during lockdown	75 patients (68.8%)

Table 2 summarizes the results of questionnaire administered to evaluate the impact during the lockdown. Median duration of visit before the lockdown and after the lockdown was 119 days (IQR, 98-159 days). The reasons for visiting after the lockdown were missed follow-up (91 patients, 83.5%), routine check-up (14 patients, 12.8%) and complaints (4 patients, 3.7%). After the lockdown, 90 patients (82.3%) were using medications properly that was comparable ( $p = 0.11$ ) to that of during the lockdown (77.1%). As seen in Table 1, the proportions of eyes with clear grafts and intact sutures decreased significantly when observed after the lockdown. Sutures were removed in 37 eyes (33.9%) after the lockdown. The clarity of grafts in 50 eyes (45.9%) was maintained well and unaffected by the lockdown as shown in Fig. 1. The unusual outcomes [Fig. 2] observed in visit of the patient after the lockdown were graft failures (40 eyes, 36.7%), graft edema (12 eyes, 11%), graft infiltrate (6 eyes, 5.5%), phthisis bulbi (2 eyes, 1.85%) and clearance of edematous graft with medications operated just before start of lockdown in 4 eyes (3.7%). The natural course of grafts may also play a role in failed or edematous grafts as well as clearing of edematous grafts. Out of 40 eyes with graft failure, 19 underwent therapeutic penetrating keratoplasty (TPK), 11 underwent penetrating keratoplasty (PK), 5 underwent PK with extracapsular cataract surgery with intraocular lens implantation, 4 underwent Descemet's stripping automated endothelial keratoplasty (DSAEK) and 1 underwent Descemet's membrane endothelial keratoplasty (DMEK). Table 3 and Fig. 3 (Kaplan Meier survival plot) shows graft survival probabilities proving that increased graft failure was not due to a temporal cause and effect relationship and there

is statistically significant reason to blame the lockdown for it. In 51 (46.79%) patients who were stable in the post-COVID-19 phase, we were able to go ahead with the plan of treatment made during the pre-lockdown visit. 31 (28.44%) patients were advised surgical intervention due to worsening during COVID-19 phase, 27 (24.77%) patients treated with topical and oral medications (stepping up of topical steroids, oral steroids etc) for graft edema.

## Discussion

The novel coronavirus (SARS CoV-2) appeared in Wuhan city of China and rapidly spread all over the world.<sup>[7]</sup> The lockdown measures to curb the growth of pandemic due to COVID-19 brought the country to a standstill as all public transport systems were stopped and free movement of public for non-essential work was restricted. The reduced OPD and surgical volume not only posed a major financial challenge to the institute, but also increased the chances of high-risk patients not receiving adequate treatment.<sup>[4]</sup>

The literature has no reports of impact of COVID-19 related national lockdown on corneal transplant patients. This is the first study in literature reporting impact of COVID-19 and the national lockdown on care of patients who underwent the corneal transplantation surgery at our centre. Supported by the EMR, we used a questionnaire for better understanding of events and problems faced by our patients during the lockdown.

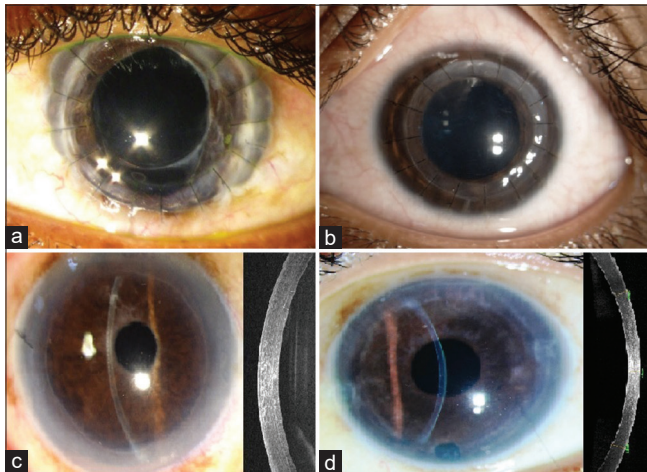
The mean age group of patients in our study, 55 years, is comparable to that in other Asian countries like Singapore or

Taiwan, where mean age was more than 55 years.<sup>[8,9]</sup> The male preponderance in our patient group is matching to the findings in other studies in India, Singapore, and Iran.<sup>[8,10-12]</sup> This may

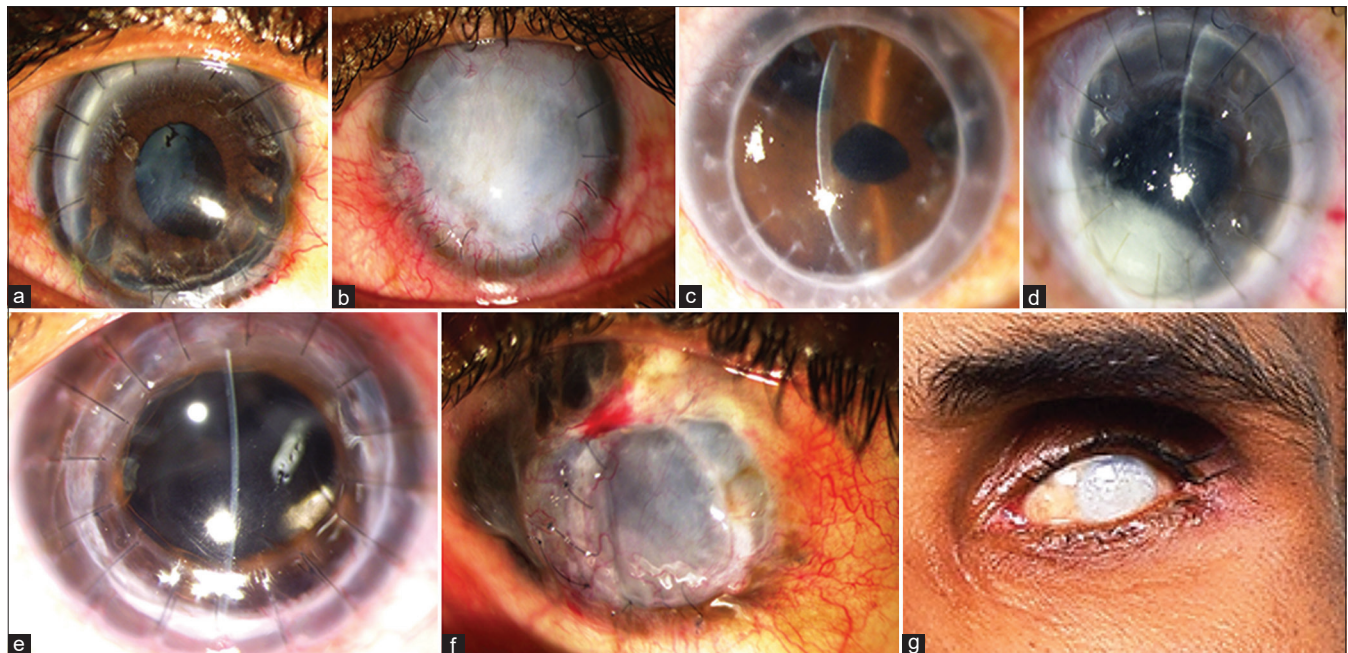
be due to the higher probability of females remaining at home involved with their children due to shutdown of schools.<sup>[4]</sup> Other possible cause may also be gender bias in accessing health care in a male-dominant society in our country.<sup>[13]</sup> Most of the patients in our study (75.23%) were from the rural area, as is also seen in other studies in India<sup>[10,14]</sup> and Nepal.<sup>[15]</sup>

In our study, 69 (63.30%) patients were coming from within 100 km distance of the hospital, while the remaining had to travel from a distance of more than 100 km. Also, 18 patients (16.51%) developed systemic illness while at home, restricting their mobility during the lockdown. On Sunday 22 March, 2020, the Government of India suspended air, train and bus modes of travel across the nation bringing to a halt flights, trains (the Indian Railways runs 13,500 passenger trains a day), and all local transport bus services till March 31<sup>st</sup>, 2020.<sup>[16]</sup> When travel restrictions were imposed as the lockdown progressed, the distance to travel to the hospital became a limiting factor. The lockdown curtailed the provision of care, further compounding the problem of patient access to care.<sup>[16]</sup> These factors had an impact on patient footfall as patients were unable to reach the eye hospital for follow-up visits.

In the visit after lockdown, 50 grafts were clear among which all patients (100%) used medications properly, whereas 59 were



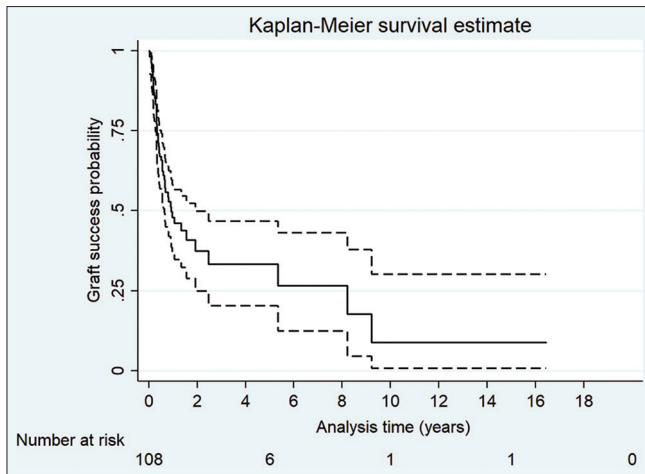
**Figure 1:** The corneal graft remained unaffected due to the lockdown in (a) Penetrating Keratoplasty. (b) Deep Anterior Lamellar Keratoplasty. (c) Descemet's Stripping Automated Endothelial Keratoplasty. (d) Descemet's Membrane Endothelial Keratoplasty



**Figure 2:** Effects of the lockdown on the corneal graft. (a) Loose sutures. (b) Graft failure. (c) Graft edema. (d) Graft infiltrate. (e) Edematous graft became clear. (f) Traumatic wound dehiscence during the lockdown. (g) Phthisis bulbi

**Table 3: Graft Survival Probabilities Over Period of Two Years After Transplant**

Months	Number at Risk	Success (%)	95% Confidence Interval
1	108	98.2% ± 1.3%	92.8% to 99.5%
3	91	85.1% ± 3.4%	76.9% to 90.6%
6	61	67.0% ± 4.7%	56.9% to 75.2%
12	28	47.9% ± 5.5%	36.8% to 58.2%
18	17	43.8% ± 5.8%	32.3% to 54.7%
24	12	37.4% ± 6.5%	25.0% to 49.9%



**Figure 3:** Kaplan Meier survival plot showing graft survival probabilities

edematous among which only 40 (67.8%) used medications properly. There was a significant ( $p < 0.0001$ ) difference between the two. Poor compliance to medications causes rapid and hazardous visual morbidity in patients who underwent corneal transplantation and policies should be developed to ensure the compliance of the patient with advised treatment.<sup>[12]</sup>

Most of patients (66.97%) in our study underwent full thickness keratoplasty (therapeutic penetrating keratoplasty or penetrating keratoplasty). In our study, the most common indication of corneal transplantation was infectious keratitis. Similarly, corneal infections were also the leading cause of keratoplasty in other studies in India and China.<sup>[12,13,17,18]</sup> Bersudsky *et al.*,<sup>[19]</sup> had concluded that visual outcome and graft survival is inversely proportional to the number of corneal re-grafts. Additional intra-operative and postoperative surgical interventions and any postoperative complications were associated with decreased survival of repeat grafts.<sup>[19]</sup> 30 (27.52%) patients in our study underwent more than one corneal transplantation in the involved eye, 18 (16.51%) patients developed post-operative complications and were at risk of reduced graft survival time.

We found that there was a significant ( $p = 0.0003$ ) drop in the proper use of medications from 91% before lockdown to 77% during lockdown, being maintained at 83% after lockdown. Most of the patients (64%) could not get or buy medicines locally, some (24%) stopped medications on their own and a few (4%) were using medications in inappropriate dosages. 8% patients of our patient group could not afford to buy medicines, which may be due to the economic losses faced by their family (69.44%) during the lockdown.

Our simple, robust, scalable electronic medical records (EMR) and hospital management systems were integrated with the teleophthalmology system which provided access to medical records at any point of time in consultation and helped us provide an accurate prescription over teleconsultation.<sup>[20]</sup> Three-fourth of the patients in our study were served by teleconsultation during the lockdown and most of them (93.90%) were satisfied with the facility. Using telemedicine technology, we found out about the general wellbeing of patients, the difficulties they faced in buying specific medicines, vision related problems, and importantly, opacity if any in the operated eye during the lockdown. Some

patients with emergency symptoms were asked to visit our hospital to get proper medical/surgical care.

Owing to the non-availability of transport vehicles and inability to afford travel to hospital using a private vehicle during the lockdown, 10% of our patients had consulted a local doctor instead of visiting our institute. The remaining 90% had avoided the doctor's consultation. The incidence of wound dehiscence due to trauma following keratoplasty in this study was 1.83%, comparable to the 0.6% to 5.8% incidence of rupture reported from other countries,<sup>[21]</sup> showing that extraneous situational factors had causing undue harm to the patient's corneal graft.

91 patients (83.49%) of our study missed their follow up in the lockdown and most of them (88.07%) were feeling anxious and stressed because of their inability to come to the hospital for follow-up during the lockdown, some presuming that negligent follow-up during the lockdown had led to their eye problem. In addition to variety of psychological problems like anxiety, depression, or panic disorder, the COVID-19 related lockdown has severely affected the life, health, livelihood and well-being of people globally.<sup>[22]</sup>

At our institute, the economic status of every patient is assessed to know the patient's affordability to pay for our ophthalmic services. For patients who are unable to pay, all our services are provided at no cost.<sup>[12]</sup> 68 (62.39%) patients belonged to the non-paying category. During the period of lockdown, around 14 crore (140 million) people lost their jobs while salaries were cut for many other employees.<sup>[23,24]</sup> Across the nation, more than 45% households reported a sudden drop in income.<sup>[25]</sup> 75 patients (68.8%) from our study too faced major economic losses during the lockdown, with loss of the job or interim salary of the earning family member, leading to their inability to travel for follow up to the eye hospital or buy medications during the lockdown.

A significant drop in the proper use of medications and loss of follow up during the lockdown, saw edematous grafts increase significantly ( $p = 0.004$ ) from 41% before the lockdown to 54% after the lockdown. The natural course of a cornea graft may also play a role here. Intact sutures decreased from 82% before the lockdown to 69% after the lockdown ( $p = 0.01$ ). 37 patients (33.94%) had loose/broken sutures which were removed under asepsis at the first opportunity - the post-lockdown visit. Lenticule attachment, GHJ apposition, BCVA, IOP and disc status in our patients were not affected significantly because of the lockdown.

We also noted in the post-lockdown follow-up visit unusual outcomes such as a failed graft (36.7%), graft edema (11%), graft infiltrate (5.56%), phthisis bulbi (1.85%), or clearing of graft edema (3.70%). In 51 (46.79%) patients, we could follow the plan of treatment made during the pre-lockdown visit. 31 (28.44%) patients were advised surgical intervention, 27 (24.77%) patients treated with topical and oral medications (stepping up of topical steroids, oral steroids, etc). The remaining patients were stable and advised regular follow-ups.

In these unprecedented times of adapting to a large scale change, where we are challenged to formulate newer mechanisms of service delivery to our patients, we need to intuitively base our decisions and strategies focussing on fluid data.<sup>[12,26]</sup> This will enable the provision of excellent, equitable

and efficient eye care services to all our corneal transplant patients in any future crisis. For instance, we proactively reached out to our patients over telephone to enquire about their well-being. Patients reported being delighted at the personal interest being taken to find out about the status of their treated/operated eye.

Our study has few limitations. The questionnaire-based patient data could not be verified for their accuracy. The primary limitation of adopting a cross-sectional study design was true for our study too as no evidence was ascertained for a temporal relationship between the exposure and its outcome.

## Conclusion

There was a significant drop in the usage of medications from 91% before lockdown to 77% during lockdown and maintained at 83% after lockdown. Edematous grafts increased from 41% before lockdown to 54% after lockdown. The natural course of grafts may also play a role here. Intactness of sutures decreased from 82% before lockdown to 69% after lockdown. Lenticule attachment, GHJ apposition, BCVA, IOP and disc status were not affected significantly because of the national lockdown.

Need for proper usage of medications, importance of teleconsultation, post-operative care and regular follow ups despite crisis period should be re-stressed to determine the success of any type of keratoplasty and consequent visual rehabilitation of the patient suffering from corneal blindness. Expectantly, lessons learned from this pandemic in managing and planning medical logistics will help the world better prepare for the unexpected, long before the outbreak of the next infectious disease.

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## Conflicts of interest

There are no conflicts of interest.

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