

Year one of COVID-19 pandemic in India: Effect of lockdown and unlock on trends in keratoplasty at a tertiary eye centre

Anthony V Das^{1,2}, Sunita Chaurasia^{3,4}, Pravin K Vaddavalli³, Prashant Garg^{3,4}

Purpose: To describe the impact of lockdown and unlock phases of the COVID-19 pandemic on keratoplasty trends at a tertiary eye care center in India. **Methods:** This cross-sectional hospital-based study included 6,277 patients presenting between March 25, 2017 and March 31, 2021. The data of the patients who underwent keratoplasty during the lockdown and unlock phases were compared with the respective periods in the previous three years before COVID-19. **Results:** During the year one of pandemic, there was a 29.46% decline in the total number of keratoplasty performed at the institute compared to previous year's annual numbers. The patients undergoing keratoplasty decreased by 90.28% (28/288) of pre-COVID-19 volumes during the lockdown phase. This was mainly because of a 40.6% reduction in the proportion of patients requiring interstate travel. There was complete recovery in the number of patients undergoing keratoplasty to 129.27% (184/142) of pre-COVID-19 volumes by March 2021. This gradual incremental trend was seen across all types of keratoplasty in Descemet stripping endothelial keratoplasty (135.29%), penetrating keratoplasty (117.6%), therapeutic keratoplasty (122.22%), anterior lamellar keratoplasty (150%), and Descemet membrane endothelial keratoplasty (141.18%) by March 2021 with the gradual ease of lockdown regulations. The eye bank affiliated to the institute saw a 55.44% decline in donor cornea collection and an increase in utilization rate from 58.12% in previous years to 83.78% in year one of the pandemic. The overall eye bank donor cornea collection recovered to 86.96% (627/721) and tissue utilization increased by 109.99% (455/414) by March 2021. **Conclusion:** The first year of the COVID-19 pandemic saw an overall reduction of 29.46% of the patients undergoing keratoplasty at the institute. There was a gradual and incremental increase in all types of keratoplasty in the unlock phase, which surpassed the preceding years' monthly numbers in February and March.

Key words: Big data, COVID-19 pandemic, eye banking, India, keratoplasty

The COVID-19 pandemic is currently raging around the world, with India in the downward phase of a devastating second wave that had an exponential rise of infections and claimed countless lives.^[1] The enforcement of the national lockdown in India last year posed significant new challenges in the access to healthcare services by the population, which was compounded by the travel restrictions.^[2] Studies from India reported a drastic reduction in patients accessing eye care services during the lockdown phase. The ocular condition that had the maximum reduction in patient volumes was those with corneal disorders.^[3]

Eye banking and cornea transplantation were notably affected by the COVID-19 pandemic.^[4] As a result of the unprecedented cessation of eye banking activities, several changes occurred in the eye banking practices and protocols. Long-term preservation method using glycerol preservation was adopted as a routine to have a reserve of corneas for tectonic indications in case the fresh donor corneas were not available or were not utilized within the shelf life of short and intermediate preservation methods of donor corneas.^[5] During

the lockdown, elective corneal transplantation declined as patients seeking care for these conditions reduced drastically. However, emergency corneal transplantation was performed.^[6]

Herein, we describe a comparative report of the effect of lockdown and unlock of the COVID-19 pandemic on the patients undergoing keratoplasty at a tertiary eye care center in India. The purpose of undertaking this study is to understand trends in eye banking and keratoplasty in the post-lock down phase and understand factors that influenced these trends.

Methods

Study design, period, location, and approval

This cross-sectional observational hospital-based study included patients presenting between March 25, 2017 and March 31, 2021 to a tertiary eye care center located in India. The clinical data of each patient who underwent a comprehensive ophthalmic examination was entered into a browser-based electronic medical records system by using a standardized template by trained ophthalmic personnel and supervised by ophthalmologists.

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¹Department of eyeSmart EMR and AEye, L V Prasad Eye Institute, ²Indian Health Outcomes, Public Health and Economics Research Center, L V Prasad Eye Institute, ³Cornea Service, The Cornea Institute, L V Prasad Eye Institute, ⁴Ramayamma International Eye Bank, The Cornea Institute, LV Prasad Eye Institute, Telangana, India

Correspondence to: Dr. Sunita Chaurasia, Cornea and Anterior Segment Services, The Cornea Institute, L V Prasad Eye Institute, Hyderabad - 500 034, Telangana, India. E-mail: sunita@lvpei.org

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A standard consent form for electronic data sharing for research purposes was signed by the patient or the parents or guardians of the patient at the time of registration. None of the identifiable parameters of the patient information was used for the analysis of the data. The study adhered to the Declaration of Helsinki and was approved by the institutional ethics committee.

Data retrieval and processing

A total of 6,277 patients of all ages underwent various types of keratoplasty, namely Descemet stripping endothelial keratoplasty (DSEK), penetrating keratoplasty (optical PK), therapeutic keratoplasty (ThPK), anterior lamellar keratoplasty (ALK), and Descemet membrane endothelial keratoplasty (DMEK) at the tertiary eye care center during the study period. The data of these patients were retrieved from the electronic medical record database and segregated in a single excel sheet (Microsoft Excel®). Data on patient demographics, ocular diagnosis, and surgical intervention were used for analysis. The excel sheet with the required data was then used for analysis using the appropriate statistical software. The study period comprised three distinct phases: Pre-COVID-19, from March 25, 2017 to March 24, 2020; Lockdown (Phase 1–4), from March 25, 2020 to May 31, 2020; and Unlock (Phase 1–10), from June 1, 2020 to March 31, 2021. The geographic categorization was performed in relation to the location of origin of the patient to the eye care center at presentation. The patients presenting from the same area of the eye center were classified as “intracity,” while those from outside the city but from the same state of the eye center were classified as “intrastate”; those from outside the state were classified as “interstate,” and those from outside India were classified as “international” patients. The demographic distribution and surgical profile of the patients in these three categories were used for comparative analysis.

Statistical analysis

Descriptive statistics using mean \pm standard deviation and median with interquartile range (IQR) were used to elucidate the demographic and clinical data using Microsoft Excel 2019 (Microsoft Corporation, Redmond, USA).

Results

Overall trend of keratoplasty at the institute

Overall, 6,277 patients underwent keratoplasty (DSEK, DMEK, Optical PK, ThPK, and ALK) during the study period. Compared to the pre-COVID-19 phase with a mean of 4.63 (5,082/1,096) keratoplasties per day, the keratoplasties performed during the lockdown phase were significantly lower with a mean of 0.41 (28/68) per day, which increased to a mean of 3.85 (1,167/303) during the unlock phase. There was no change in the mean (48.49 ± 20.04 years vs. 47.08 ± 21.93 years) and median [51 (IQR: 35–65) years vs. 51 (31–65) years] age of patients during the COVID-19 pandemic phase (lockdown and unlock phases included) as compared to the pre-COVID-19 phase. There was a statistically significant ($P = 0.000871$) decrease in access to keratoplasty (8.2%) in the proportion of pediatric patients (≤ 16 years) during the COVID-19 phase as compared to the pre-COVID-19 phase (11.94%). There was no major gender difference in access to care among the male (63.85% vs. 60.61%; $P = 0.312892$) and female (36.15% vs. 39.39%; $P = 0.165949$) patients. The trend of the keratoplasty surgeries over the three phases is detailed in Fig. 1. Regarding geographic presentation, a reduction of 40.6% was seen in keratoplasty performed in patients requiring interstate travel and an increase of 225.82% was seen in patients requiring intrastate travel during the lockdown phase. There was a

complete recovery in keratoplasty performed (99.45%) for patients requiring interstate travel and 113.52% for intracity surgeries during the unlock phases. There was a reduction of 82.28% in patients undergoing keratoplasty requiring international travel during the unlock phase. A detailed comparison of the geographic location of patients and the trends in all three phases is described in Figs. 2 and 3.

Specific trends of keratoplasty at the institute

The yearly average of TPK increased from 395 to 428 surgeries, while the monthly average increased from 33 to 36 surgeries, which exceeded the pre-COVID-19 monthly average by June 2020. The yearly average of PK decreased from 465 to 262 surgeries, whereas the monthly average reduced from 39 to 22 surgeries and matched the pre-COVID-19 monthly average by December 2020. The yearly average of DSEK decreased from 568 to 371 surgeries, while the monthly average reduced from 47 to 31 surgeries but showed a gradual increasing trend to match the pre-COVID-19 monthly average by January 2021. The yearly average of DMEK decreased from 123 to 66 surgeries, whereas the monthly average reduced from 10 to 6 surgeries and showed a gradual increasing trend to exceed the pre-COVID-19 monthly average by February 2021. The yearly average of ALK decreased from 143 to 68 surgeries, whereas the monthly average reduced from 12 to 6 surgeries and showed a gradual increasing trend to match the pre-COVID-19 monthly average by October 2020. A detailed comparison of the abovementioned trends of keratoplasty in the pre-COVID-19 and COVID-19 phases is described in Fig. 4 and Table 1.

Specific trends of eye banking in donor collection and utilization

The yearly average of corneal tissue collection during the pre-COVID-19 phase was 7,309, which reduced to 3,257 during the COVID-19 phase. The monthly average also reduced from 609 corneal tissues (pre-COVID) to 271 corneal tissues (COVID-19 phase) and matched the pre-COVID-19 monthly average by February 2021. The yearly average of corneal tissue utilization during the pre-COVID-19 phase was 4,248, which reduced to 2,729 during the COVID-19 phase. The monthly average also reduced from 609 corneal tissues (pre-COVID) to 271 corneal tissues (COVID-19 phase) and matched the pre-COVID-19 monthly average by December 2020. The percentage of corneal tissue collection to performed keratoplasty during the COVID-19 phase was 95.83% in May 2020 and decreased to 29.35% by March 2021. The percentage of corneal tissue utilization to performed keratoplasty internally in the tertiary center during the COVID-19 phase was 104.55% in May 2020 and decreased to 40.44% by March 2021, while external utilization of corneal tissue during the COVID-19 phase was 3.26% in July 2020 and increased to 59.56% by March 2021. A detailed comparison of the abovementioned trends of corneal tissue collection and utilization in the pre-COVID-19 and COVID-19 phases is described in Fig. 5 and Table 2.

Discussion

This study sought to describe the impact of lockdown and unlock phases of the COVID-19 pandemic on keratoplasty types and volumes at a tertiary eye care center in India. We analyzed the clinical profile of patients and the keratoplasty types in the initial year one of the pandemic with the averages of the preceding 3 years' annual numbers to have a better comparative understanding of the magnitude of the impact of the pandemic. The nationwide lockdown in response to

the pandemic that lasted for 70 days posed challenges such as intra and interstate travel. This was somewhat mitigated in the unlock phases when travel restrictions were relaxed in a staggered manner in the later months of the year. The overall trends in the increase in patients consulting for keratoplasty showed a steady linear growth in the unlock phase of the pandemic. The relative distribution of the geographical location of patients that underwent keratoplasty, depicted in Fig. 3, shows that there was a sharp decline in patients consulting from outside the state and a complete decline in overseas patients during the lockdown, followed by a nearly superimposed pattern suggestive of near recovery in the unlock phase.

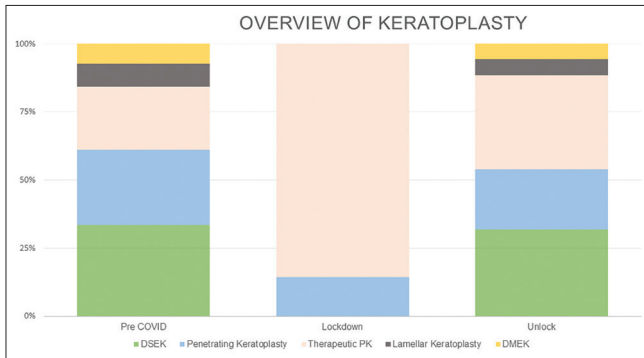


Figure 1: Overview of performed keratoplasty in patients presenting during the Pre-COVID-19, Lockdown (Phase 1–4), and Unlock (Phase 1–10) in India

Overall, we observed that there was a 29.46% reduction in the total number of keratoplasties at our center compared to the average of previous years' annual numbers. There was a decline of 43.7%, 54.45%, 34.68%, and 46.34% in optical PK, ALK, DSEK, and DMEK, respectively, and an increase of 8.45% in ThPK compared to previous years. The marginal increase in ThPK compared to other surgeries is likely due to the advanced nature of the infectious keratitis seen during the pandemic times. This is substantiated by another study from our center that showed that the presenting visual acuity of patients with keratitis was significantly worse in the first year of the pandemic relative to the previous year's presenting visual acuity (*unpublished data, in review*). The monthly trends of the number of keratoplasties showed consistently increasing numbers above the previous years from January to March 2021. There was no waiting time for keratoplasty at the institute during the unlock phase as the eye bank collection of donor corneas was above the number of patients who needed keratoplasty. A reserve of glycerol preserved corneas was maintained at the eye bank throughout the year in the event of any unforeseen shortage of fresh donor corneas. The increasing trends and ability to sustain keratoplasty without waiting times highlights the eye bank preparedness that is paramount in managing the increase in surgical backlogs.

At our institute-affiliated eye bank, the eye banking activities were resumed amidst the lockdown phase (May 11) to meet the anticipated shortage of fresh donor corneas during the unlock phase.^[5] The overall collection of donor corneas was 55.44% less than that of previous years. Although there was a 35.75% decline

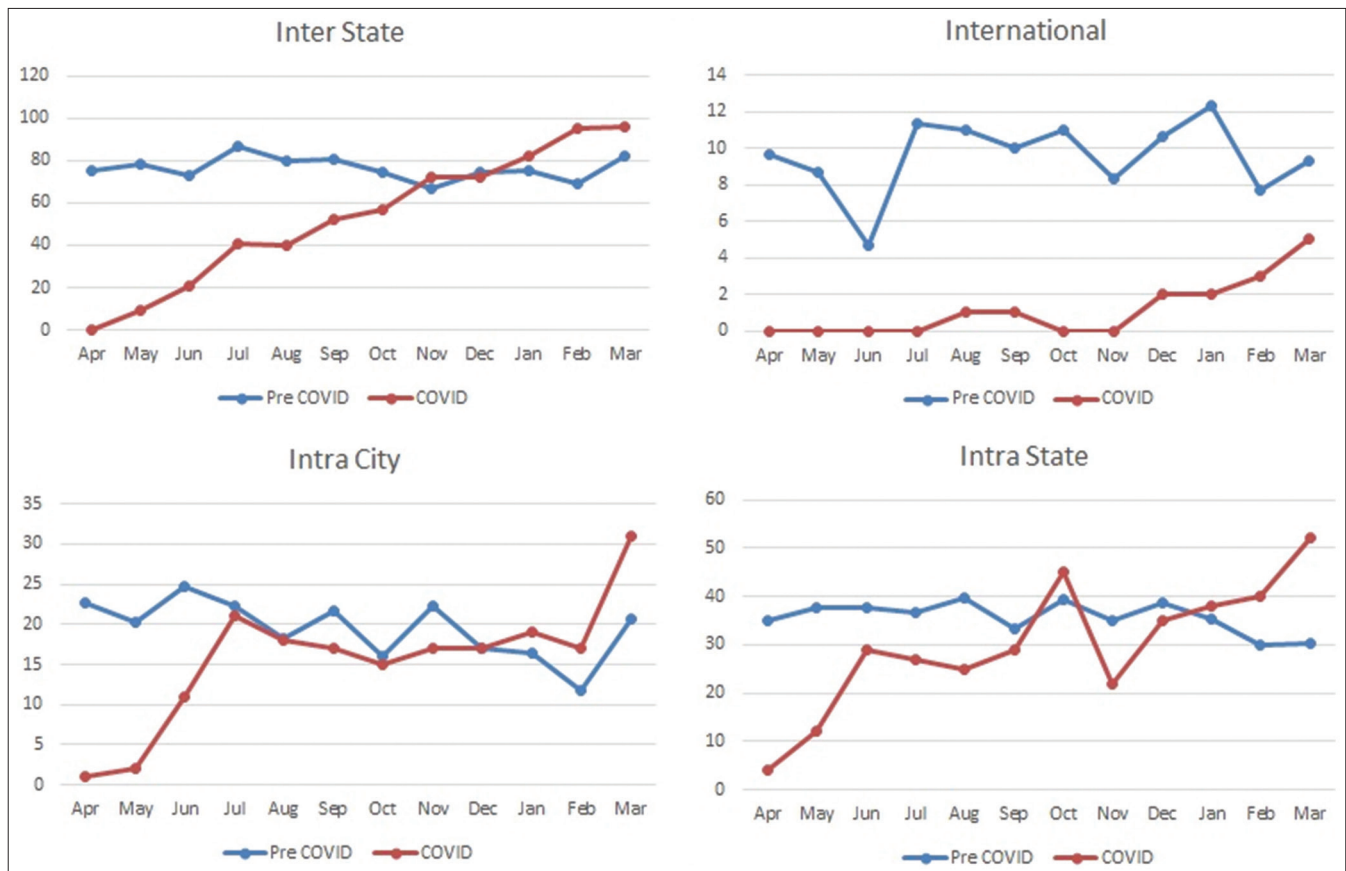


Figure 2: Trends of patient volumes from various geographical regions

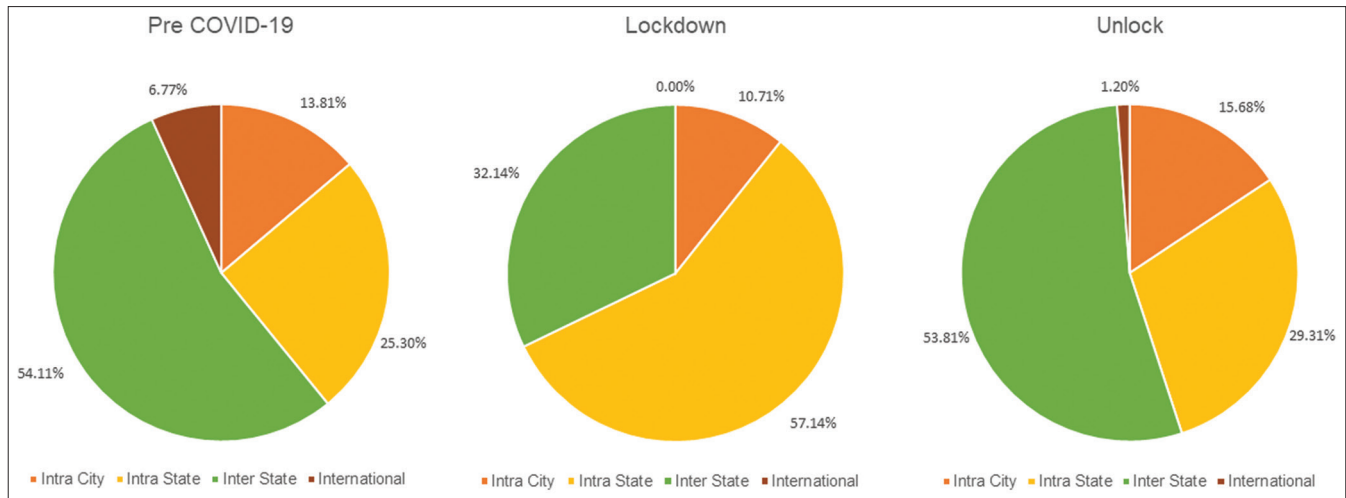


Figure 3: Geographic distribution of performed keratoplasty in patients presenting during the pre-COVID-19, Lockdown (Phase 1–4), and Unlock (Phase 1–10) in India

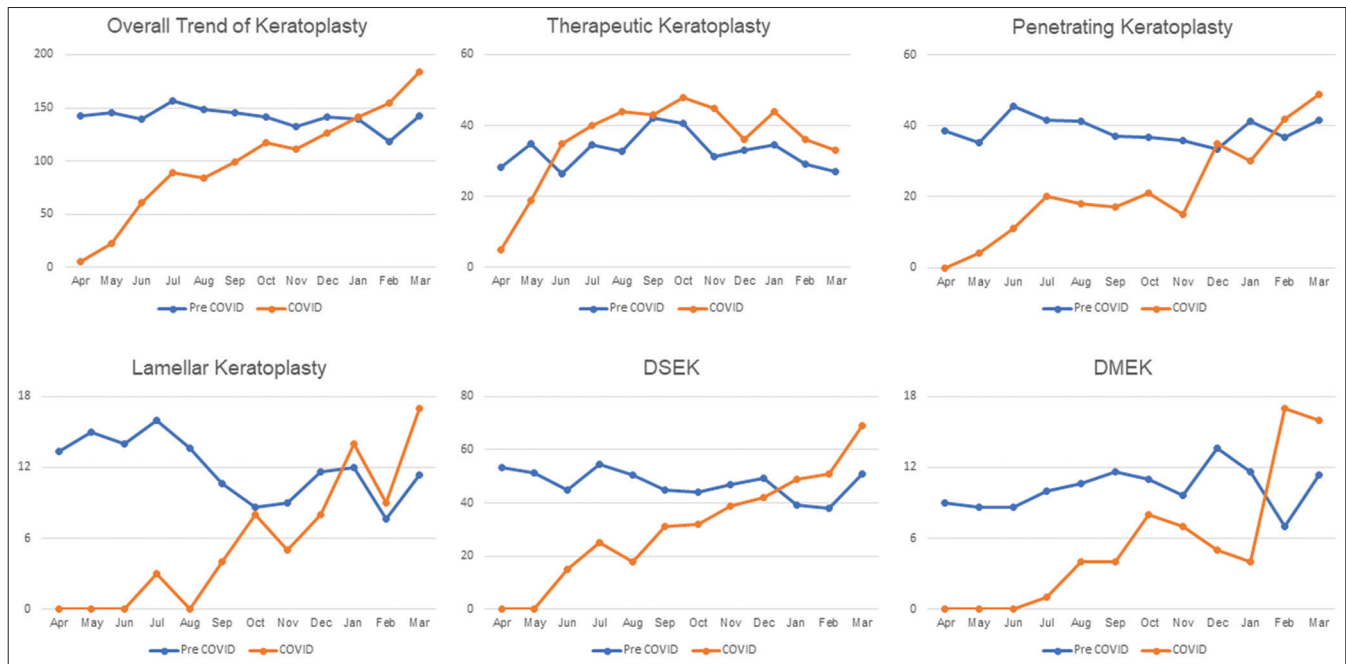


Figure 4: Monthly distribution of performed keratoplasty in patients during the Pre COVID-19, Lockdown (Phase 1–4), and Unlock (Phase 1–10) in India

Table 1: Distribution and Change in Yearly number of keratoplasties during the Pandemic

| Parameters | Pre-COVID-19 (Average numbers of 3 preceding years) | Post-COVID-19 | | | % Change (Pre and Post COVID-19) |
|--------------------|--|---------------|--------------------------------|--------------------------------------|--|
| | | Overall | Lockdown (25 Mar-31 May'20) | Post Lockdown (1 June-31 Mar '21) | |
| Total Keratoplasty | 1694 | 1194 | 28 | 1166 | ↓ 29.46% |
| PK | 465 | 262 | 4 | 258 | ↓ 43.7% |
| ThPK | 395 | 428 | 24 | 404 | ↑ 8.45% |
| ALK | 143 | 68 | 0 | 68 | ↓ 54.45% |
| DSEK | 568 | 371 | 0 | 371 | ↓ 34.68% |
| DMEK | 123 | 66 | 0 | 66 | ↓ 46.34% |

in total performed keratoplasties (29.46% within the institute and 39.54% at external eye care centers) when compared to the previous years' figures, the utilization rate showed an increase

from 58.12% to 83.78% in the pre- and post-COVID-19 times. It is likely that the early months of the unlock phase with a relative shortage of donor corneas inevitably resulted in the reduction

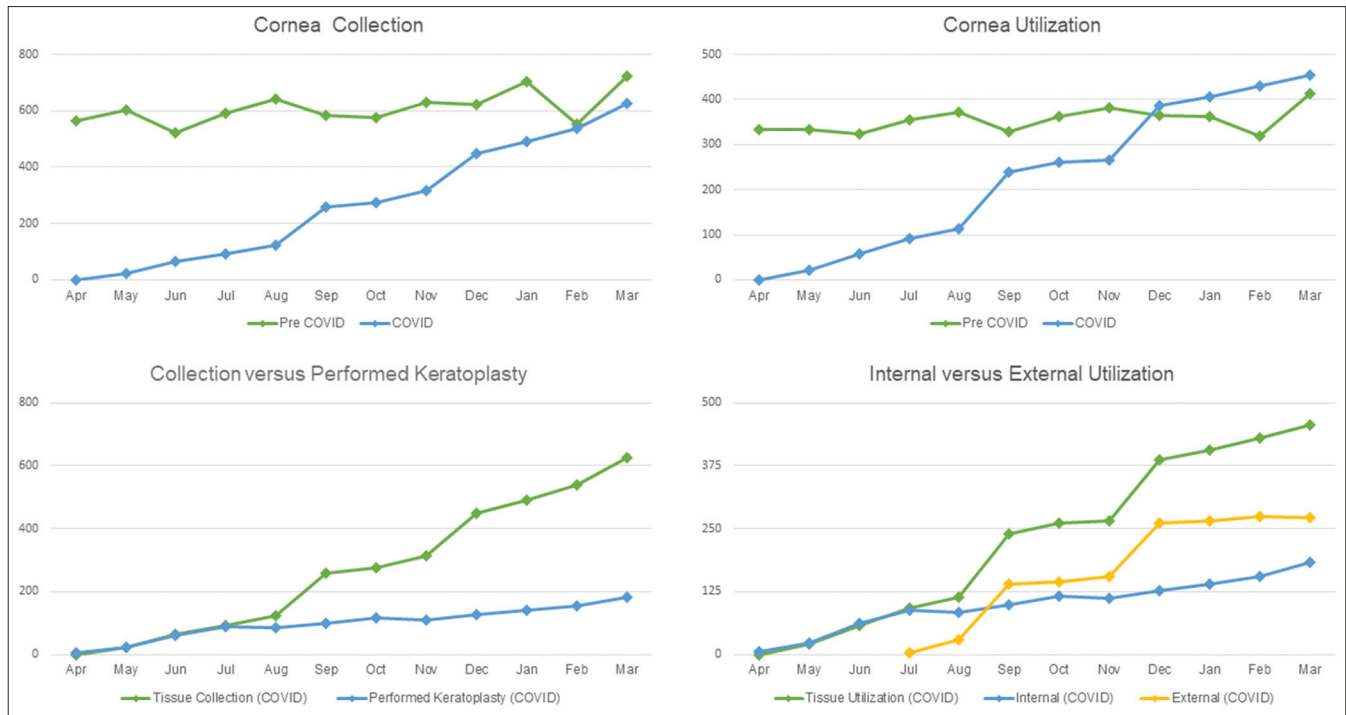


Figure 5: Monthly distribution of cornea collection and utilization by the eye bank during the pre-COVID-19, Lockdown (Phase 1–4), and Unlock (Phase 1–10) in India

Table 2: Comparison of donor cornea collection and utilization before and year one of COVID-19 pandemic

| Parameters | Pre-COVID-19 (Average numbers of 3 preceding years) | Post-COVID-19 | | | % Change (Pre and Post COsVID) |
|---------------------------|--|---------------|--------------------------------|--------------------------------------|---|
| | | COVID-19 | Lockdown (25 Mar-31 May'20) | Post Lockdown (1 June-31 Mar '21) | |
| Collection | 7309 | 3257 | 24 | 3233 | ↓ 55.44% |
| Utilization | 4248 | 2729 | 22 | 2707 | ↓ 35.75% |
| Internal/Within Institute | 1694 | 1195 | 28 | 1167 | ↓ 29.46% |
| External Eye care Centers | 2554 | 1544 | 0 | 1544 | ↓ 39.54% |

of discard rates on account of factors such as less than “ideal” endothelial health, thereby optimizing the utilization of each donor cornea harvested during this time. Another possibility is that due to the adoption of added contraindications in donor recovery protocols on donors with COVID-19 and COVID-like symptoms (which had a predilection for older patients in the first phase), there was a selective shift toward those donors that would more likely be considered suitable for corneal transplantation. A detailed analysis of the donor causes of the death in year one of the pandemic will be insightful.

Conclusion

In conclusion, the authors present their experience on the impact of the COVID-19 pandemic on keratoplasty at a tertiary eye care center in India. The first year of the COVID-19 pandemic saw a drastic reduction in the patients undergoing keratoplasty in the lockdown phase, which showed trends toward recovery during the unlock period.

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Conflicts of interest

There are no conflicts of interest.

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