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ORIGINAL RESEARCH

Impact and Determinants of COVID-19 Pandemic on the Cataract Surgery Rate at a Tertiary Referral Center

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Purpose: Preventive measures to mitigate the spread of coronavirus, minimized workload on health-care systems and redirected resources to COVID-19 patients resulting in a reduction of elective procedures such as cataract surgery. We report the changes in monthly cataract surgery rate and its associated determinants at a tertiary eye hospital during different periods of the pandemic. Studying the impact of COVID-19 pandemic on cataract surgery rate will help health-care policymakers to better understand the barriers to overcome the expected surgical backlog.

Methods: A retrospective review of medical records was performed for cataract surgeries from November 2018 to January 2022, five thousand and ninety-two eyes that underwent cataract surgery during different phases of the COVID-19 pandemic were included. The monthly cataract surgery rate (MCSR) was calculated and compared before (Phase 1), during (Phase 2) and after the COVID-19 pandemic (Phase 3 and 4). Changes in monthly cataract surgery rate during and after the pandemic were presented as ratios and compared pre- to post-pandemic levels to evaluate the impact of different determinants.

Results: Of 9701 cataract patients, 5092 (52.5%) were operated in P1, 71 (0.73%) in P2, 116 (1.2%) in P3 and 4422 (45.6%) in P4. The MCSR varied significantly based on the degree of visual impairment in the operated and fellow eyes, and by the type of operating surgeon ($P < 0.05$). Age, gender, laterality, and place of residence were not significantly different throughout the study period. During phase 1135 (2.6%) eyes had rupture of the posterior capsule (PCR), while 6 eyes (8.4%) had PCR in phase 2.

Conclusion: The monthly cataract surgery rate declined during the pandemic and has not recovered to pre-pandemic levels. This should alert the key stakeholders to address the identified barriers to surpassing the baseline monthly surgical rate as this is crucial to eliminate the surgical backlog after the pandemic.

Keywords: cataract, Covid-19, surgery, rate, backlog

Introduction

The World Health Organization (WHO) declared COVID-19 as a global pandemic in March 2020.[1] Based on the severity of the pandemic and availability of resources, actions were taken regarding surgical practices, which led to postponement of non-critical surgeries.[2–7] In ophthalmology, elective surgeries, including cataract surgery, were deferred following the American Academy of Ophthalmology (AAO) guideline issued in March 2020.[8–11] The impact of suspending cataract surgery during the COVID pandemic may be reflected in higher caseloads and larger surgical backlogs over time.[12]

Early on during this pandemic, King Khaled Eye Specialist Hospital (KKESH), in Riyadh, Saudi Arabia, which is a central referral tertiary eye care facility, limited outpatient clinic visits and utilized telemedicine to contact patients and manage non-emergent cases. Furthermore, elective surgical procedures, including cataract surgery, were suspended starting from the 23rd of March 2020 for 3 successive months. Accordingly, surgeons were only performing emergency surgeries as per the AAO developed guidelines,[8–11] as well as similar guidelines developed by the United Kingdom and Ireland Society of Cataract and

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Refractive Surgeons (UKISCRS).[10,13] Additionally, starting from 23rd of March 2020, patients were screened for COVID-19 using a polymerase chain reaction (PCR) testing 2 days prior to surgery.

The cataract surgery rate (CSR) is a measure used to monitor the progress of countries in eliminating blindness due to cataract. The WHO has recommended a minimum of 2000 surgeries per year per one million population as a threshold.[14] The CSR in Saudi Arabia prior to the pandemic has never been reported; however, data presented in an annual scientific meeting of Ophthalmologists in 2015 reported a CSR of 2150/million/year.[15] The main stakeholders of ophthalmic services provided in the Kingdom are the governmental and private sectors. Government hospitals, such as KKESH, which is one of the largest tertiary referral hospitals in the Middle East. KKESH is also a teaching and training hospital for residents and fellows from all over the kingdom. The usual cataract cases that are referred to KKESH may include routine cases that are performed by trainees and the more complicated cases that require experienced surgical skills. This contrasts with cataract cases that are operated in the private sector which caters primarily to less complicated cases and are mainly performed to improve quality of life rather than treating blindness.

To date, there is no accurately reported pre, intra and post-pandemic CSR from Saudi Arabia. Thus, our primary objective is to report the monthly CSR in the largest tertiary eye care center in Saudi Arabia before, during and after the pandemic, as well as to highlight the impact of COVID-19 on different age groups, gender, and areas of residence. Our goal is to report our findings to health-care authorities and policymakers to address the barriers to improve the rate of cataract surgery uptake, especially among less privileged individuals.

Methods

In this retrospective review of medical records, we evaluated cataract patients presenting to King Khaled Eye Specialist Hospital from November 1, 2018 to January 6, 2022. A standard consent form for electronic data sharing for research purposes was signed by the patient at the time of registration. None of the identifiable parameters of the patient information were used for the analysis of the data. The study adhered to the Declaration of Helsinki and was approved by the Institutional Research Board (KKESH, RP 21089-R) at King Khaled Eye Specialist Hospital. The study period was classified into four phases; pre-Covid-19 phase which extended from November 1, 2018 to March 22, 2020 (P1, total of 17 months), the Covid-19 lockdown phase from March 23, 2020 until July 6, 2020 during which all elective procedures were suspended (P2, total of 3.5 months), the first post-Covid-19 recovery phase from July 7, 2020 to August 8, 2020 (P3, total of 1 month), where cataract surgeries resumed in partial capacity with a maximum of two cataract surgeries per session, while the second post-Covid-19 recovery phase started from August 9, 2020 until January 6, 2022 during which all cataract surgeries resumed to full capacity (P4, total of 17 months).

Data were collected on patients who underwent cataract surgery during the study period including their age, gender, place of residence, preoperative visual acuity of the operated eye and the fellow eye at the time of surgery, as well as intraoperative complications such as, anterior capsular extension, aqueous misdirection, Descemet membrane detachment, hyphema, iridodialysis, zonular dialysis, wound burn, posterior capsular rupture (PCR) with or without vitreous loss, and suprachoroidal hemorrhage. If both eyes of the same patient underwent surgery during the study period, then each eye was recorded as a separate record. Preoperative visual impairment was classified as; blind (<20/400), severe visual impairment (20/300 to 20/400), moderate visual impairment (20/60 to 20/200) and normal vision (>20/50).

The monthly cataract surgery (MCS) number and rate (MCSR) were calculated and compared for each given period. MCSR was calculated by dividing the total number of cataract surgeries performed in each period over the number of months included in the same period. Meanwhile, the MCSR ratio was calculated by dividing the MCSR of each period by the rate for P1, as it was used as a reference point for the pre-COVID phase. Also, the monthly cataract surgery rate and ratio were calculated and compared based on age and gender of the patient, laterality, preoperative visual acuity in both operated and fellow eyes, the patient's residence, and level of surgeon experience (consultant vs trainee -resident/fellow-) to investigate whether any of these determinants had any impact on the outcome.

The data were accessed with the help of the information technology and communication department using the surgical procedural code (Australian modification, ICD-10-AM) for cataract surgery. Data were then stored in Microsoft Excel 365 (Microsoft Corporation, Redmond, Washington, USA). Data verification, management, and coding were performed with Excel 365. SPSS version 26 (IBM Inc., Chicago, Illinois, USA) was used for statistical analysis. Categorical variables are

reported as frequencies and percentages while continuous variables are reported as mean (±SD), range [min – max]. Inferential analysis was conducted using Chi squared for associations between categorical variables. Means were compared with the Student's *T*-test while one-way analysis of variance (ANOVA) was used to compare means of more than two groups. The confidence interval level was set to 95% where a corresponding *p*-value less than 0.05 was considered statistically significant.

Results

The study sample was comprised of 9701 cataract surgeries, where 4878 (50.3%) of eyes were from male patients and 4823 (49.7%) were from female patients. An overview of patients' demographics including age, gender, place of residence, best corrected visual acuity of the operated and fellow eye, as well as the level of operating surgeon, is displayed in Table 1, results were categorized based on the previously defined study periods. Figure 1 presents the change in monthly cataract surgery rate (MCSR) ratio by patient gender.

Table 1 Overview of Patients Undergoing Cataract Surgery Before, During and After COVID-19 Pandemic

Variable	P1 No. (%)	P2 No. (%)	P3 No. (%)	P4 No. (%)	*P* value
Total number of surgeries	5092	71	116	4422	
Monthly CS rate	299	20	116	260	
Age in years					
20 or less	43 (0.8%)	1 (1.4%)	0	30 (0.7%)	0.097
21–40	273 (5.4%)	8 (11.3%)	11 (9.5%)	261 (5.9%)	0.097
41–60	1703 (33.4%)	29 (40.8%)	28 (24.1%)	1378 (31.2%)	0.097
61–80	2828 (55.5%)	31 (43.7%)	71 (61.2%)	2539 (57.4%)	0.097
>80	245 (4.9%)	2 (2.8%)	6 (5.2%)	214 (4.8%)	0.097
Gender					
Male	2517 (49.4%)	40 (56.3%)	62 (53.4%)	2259 (51%)	0.11
Female	2575 (50.6%)	31 (43.7%)	54 (46.6%)	2163 (49%)	0.11
Place of residence					
Central	3133 (61.5%)	54 (76.1%)	78 (67.2%)	2735 (61.8%)	0.39
East	132 (2.6%)	2 (2.8%)	2 (1.7%)	100 (2.3%)	0.39
North	356 (7%)	3 (4.2%)	6 (5.2%)	315 (7.1%)	0.39
West	524 (10.3%)	3 (4.2%)	13 (11.2%)	489 (11.1%)	0.39
South	947 (18.6%)	9 (12.7%)	17 (14.7%)	783 (17.7%)	0.39
Laterality					
OD	2563 (50.3%)	31 (43.7%)	52 (44.8%)	2218 (50.2%)	0.63
OS	2529 (49.7%)	40 (56.3%)	64 (55.2%)	2204 (49.8%)	0.63
BCVA in operated eye					
20/20 to 20/50	842 (16.5%)	5 (7%)	15 (13%)	826 (19%)	<0.001
20/60 to 20/200	2164 (42.5%)	32 (45%)	46 (40%)	1775 (40%)	<0.001
20/300 to 20/400	776 (15%)	10 (14%)	20 (17%)	641 (14.5%)	<0.001
Less than 20/400	1310 (26%)	24 (34%)	35 (30%)	1180 (26.5%)	<0.001
BCVA in fellow eye					
20/20 to 20/50	1554 (30.5%)	13 (18%)	31 (27%)	1449 (33%)	0.007
20/60 to 20/200	1915 (37.5%)	24 (34%)	43 (37%)	1605 (36%)	0.007
20/300 to 20/400	607 (12%)	10 (14%)	14 (12%)	482 (11%)	0.007
Less than 20/400	1016 (20%)	24 (34%)	28 (24%)	886 (20%)	0.007
Operating surgeon					
Consultant	2854 (56%)	45 (63.4%)	71 (61%)	2184 (49.4%)	0.001
Trainee	2238 (44%)	26 (36.6%)	45 (39%)	2238 (50.6%)	0.001

Notes: *P* < 0.05 is statistically significant; BCVA denotes best corrected visual acuity; OD denotes right eye; OS denotes left eye; CS denotes cataract surgery; P1 denotes pre-Covid-19 phase which extended from November 1, 2018 to March 22, 2020; P2 denotes the Covid-19 lockdown phase from March 23, 2020 until July 6, 2020 during which all elective procedures were suspended; P3 denotes the first post-Covid-19 recovery phase from July 7, 2020 to August 8, 2020 where cataract surgeries resumed to partial capacity with a maximum of two cataract surgeries per session; P4 denotes the second post-Covid-19 recovery phase from August 9, 2020 to January 6, 2022 during which all cataract surgeries resumed to full capacity.

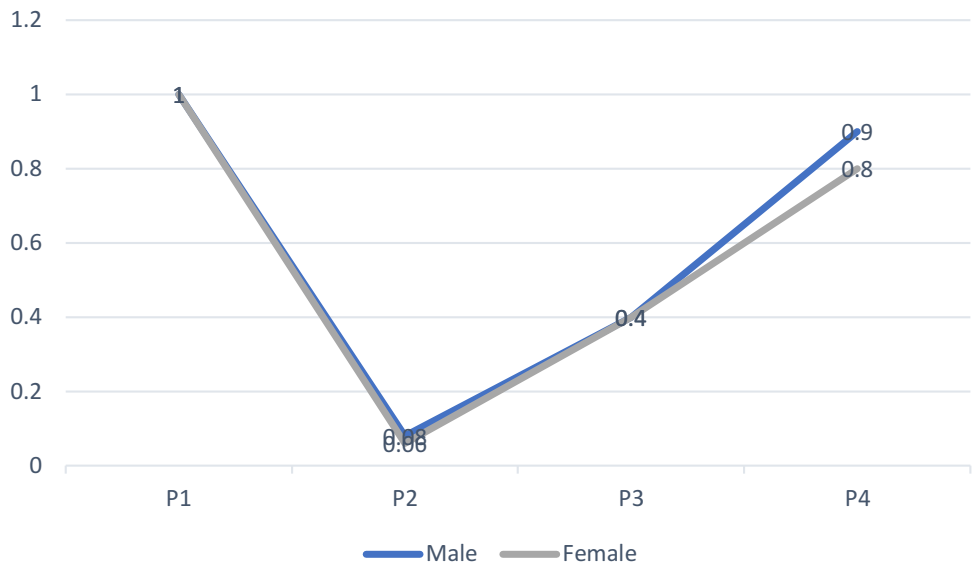

Figure 1 Monthly cataract surgery rate ratio by gender of patient.
Notes: P1 denotes pre-Covid-19 phase which extended from November 1, 2018 to March 22, 2020; P2 denotes the Covid-19 lockdown phase from March 23, 2020 until July 6, 2020 during which all elective procedures were suspended; P3 denotes the first post-Covid-19 recovery phase from July 7, 2020 to August 8, 2020 where cataract surgeries resumed to partial capacity with a maximum of two cataract surgeries per session; P4 denotes the second post-Covid-19 recovery phase from August 9, 2020 to January 6, 2022 during which all cataract surgeries resumed to full capacity.

Prior to COVID-19 pandemic, the MCSR was highest among patients residing in the central region of Saudi Arabia at a rate of 184 eyes/month, followed by the southern region (56 eyes/month) then the western region (31 eyes/month). At the beginning of the pandemic the MCSR rate decreased significantly throughout all regions, yet the central area consistently had the highest rate at 15 eyes/month ($p<0.05$). During P4, MCSR returned to the baseline pattern where MCSR was highest for the central region (161 eyes/month), and lowest for the eastern region (6 eyes/month); however, this difference was not statistically significant ($p = 0.39$) (Table 1). Consultants had higher MCSR during P2 (13 eyes/month) and P3 (71 eyes/month) compared to trainees (7 eyes/month in P1 and 45 eyes/month in P2), while in P4 trainees surpassed consultants with a rate of 132 eyes per month. Figure 2 illustrates the MCSR ratio by level of experience of surgeon.

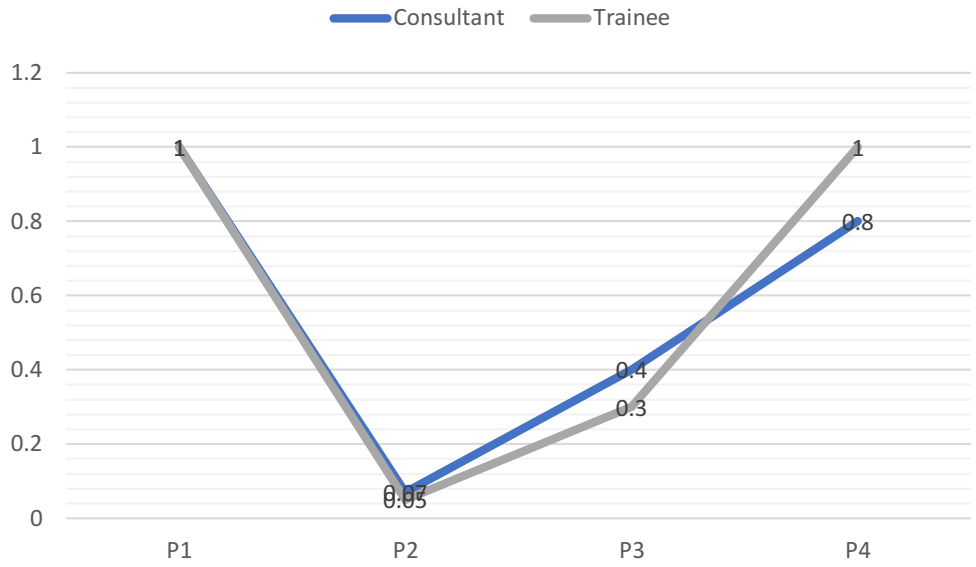

Figure 2 Monthly cataract surgery rate ratio by experience level of surgeon.
Notes: P1 denotes pre-Covid-19 phase which extended from November 1, 2018 to March 22, 2020; P2 denotes the Covid-19 lockdown phase from March 23, 2020 until July 6, 2020 during which all elective procedures were suspended; P3 denotes the first post-Covid-19 recovery phase from July 7, 2020 to August 8, 2020 where cataract surgeries resumed to partial capacity with a maximum of two cataract surgeries per session; P4 denotes the second post-Covid-19 recovery phase from August 9, 2020 to January 6, 2022 during which all cataract surgeries resumed to full capacity.

Table 2 Cataract Surgery Rate Based on Intraoperative Complication Rate

	Yes		No		Validation
	No. (%)	Rate per Month	No. (%)	Rate per Month	
P1	233 (4.57%)	14	4859 (95.43%)	286	$P = 0.260$
P2	6 (8.45%)	2	65 (91.55%)	18.5	
P3	4 (3.45%)	4	112 (96.55%)	112	
P4	170 (3.84%)	10	4252 (96.16%)	250	

Notes: $P < 0.5$ is statistically significant; P1 denotes pre-Covid-19 phase which extended from November 1, 2018 to March 22, 2020; P2 denotes the Covid-19 lockdown phase from March 23, 2020 until July 6, 2020 during which all elective procedures were suspended; P3 denotes the first post-Covid-19 recovery phase from July 7, 2020 to August 8, 2020 where cataract surgeries resumed to partial capacity with a maximum of two cataract surgeries per session; P4 denotes the second post-Covid-19 recovery phase from August 9, 2020 to January 6, 2022 during which all cataract surgeries resumed to full capacity.

The MCSR with intraoperative complications is shown in Table 2. Posterior capsule rupture (PCR) occurred in 2.65% of eyes during P1, 8.45% of eyes in P2, 1.72% of eyes in P3 and 2.48% of eyes in P4. The rate of PCR in cases performed by residents increased from 8.8% of eyes in P1 to 15.5% in P4.

Discussion

This is a single-centered retrospective review of electronic health data of patients who underwent cataract surgery (CS) centered around the COVID-19 pandemic. The outcomes of our study indicate that the MCSR and ratio varied significantly throughout the study period based on the degree of visual impairment of both the operative and fellow eye and the surgeon experience ($p<0.05$). However, age, gender, laterality, and place of residence were not significantly different throughout the study period ($p>0.05$). In our institute, the MCSR did not recover to baseline levels following the pandemic. Similarly, Dmuchowska et al[16] reported that despite the gradual increase in the number of monthly cataract surgeries following the first wave of the pandemic, yet it failed to reach the pre-pandemic reference level. This observation concurs with a German study which reported that most ophthalmic procedures, especially cataract surgery, continued to decline even after stabilization of the provided health-care services following the pandemic.[17] Following the worldwide pandemic lockdown, there has been a significant backlog of operable cataract surgeries,[12,18] and this backlog is expected to increase. However, the number of health-care staff and operating room availability can vary based on staff being affected by COVID which will inhibit timely clearance of this backlog. These observations should alert the key health-care stakeholders and policymakers to structure a post-pandemic recovery plan in preparation of the expected backlog of elective procedures.

The majority of patients who underwent cataract surgery prior to the pandemic were over 61 years of age, while during the pandemic lockdown period, younger patients more frequently underwent surgery. Similar outcomes have been reported from previous studies,[19] and may be due to the increased mortality rate of elderly from SARS-CoV-2 infection,[20] which led health-care professionals to postpone elective surgeries for the elderly. Although there is a considerable risk of morbidity and mortality from SARS-CoV-2 infection among the elderly, delaying cataract surgery can have detrimental effects on the vision-related quality of life, such as increased risk of falls, and a negative impact their on their psychological wellbeing.[21–25] Multiple studies have suggested several guidelines and measures to resume cataract surgery post-COVID.[26–28] Following these guidelines can potentially facilitate cataract surgery for the elderly while mitigating the risk of SARS-CoV-2 infection.

Our institution provides services to patients from different regions in Saudi Arabia. However, the largest proportion of patients included in this study reside in the central region of Saudi Arabia, and that was consistent throughout the study period. This finding is expected as the hospital is in Riyadh which is easily accessible especially during the early months of the pandemic when the Ministry of Health announced curfews that restricted mobility of much of the population. We observed that there was a much lower proportion of patients from outlying cities compared to more central cities presenting for surgery during the lockdown period. These observations concur with a previous study which reported that patients living far from the surgical center were less likely to undergo cataract surgery during the pandemic due to fear of

contracting SARS-CoV-2 infection during their travel.[19] These findings highlight the importance of balanced distribution of health-care services throughout the country to ease the accessibility to care for patients living in remote areas. Such initiatives would include, establishing medical cities with well-equipped ophthalmology departments with skilled eye surgeons in each of the major regions of Saudi Arabia.[29]

In our institute, during the pandemic most of the surgeries were performed by consultants as the patients scheduled for surgery were considered to have complex cataracts that required experienced surgeons. Notably, during the recovery phase, trainees were able to resume their MCSR to the same exact level prior to the pandemic (132 eyes per month). This was likely due to the decision that trainees require greater surgical exposure and extra operating theater (OR) teaching sessions were scheduled with routine cataract patients to address the shortfall during the early pandemic phases. Multiple studies investigating the impact of the pandemic on residency training reported a significant impact on training outcomes, especially among residents from surgical specialties.[30–32] These observations should urge residency program directors to initiate policies and solutions to overcome the shortcomings of training due to the current pandemic.

The overall rate of intraoperative complications during the early months of the pandemic from March 2020 to July 2020 doubled compared to the baseline rate, and further analysis revealed that PCR significantly increased during the pandemic and especially among cases undergoing surgery by trainees. This is similar to Theodoraki et al's[33] study that reported rate of PCR with vitreous loss almost tripled compared to pre-pandemic levels following the resumption of cataract surgeries after the lockdown. This increase could be attributed to the fact that during the pandemic, only urgent and more complicated cataract surgeries were performed, which consequently led to higher chance of intraoperative complications. More importantly, our institute is considered one of the largest teaching hospitals in the region, where straightforward cataract surgeries are mainly operated by residents, while anterior segment fellows are trained on more complex cataract surgeries, which might have led to the increase in the intraoperative complications noted in this study.

Our analysis indicated that patients with moderate to very severe visual impairment either in the operative eye or in the fellow eye were prioritized during the pandemic. Another recent study by Theodoraki et al[33] found that preoperative best corrected visual acuity (BCVA) of patients during and after the pandemic was significantly worse compared to that were conducted prior to the pandemic. A study investigating the impact of the pandemic on a Greek tertiary hospital found that the percentage of eyes with white cataract have doubled compared to pre-pandemic level, suggesting the negative impact on delayed patient management.[34]

Although it is important to prioritize patients with worse BCVA while restoring normal cataract surgery services, it is also equally important to consider the visual needs of the patients and their quality of visual life. Ting et al[35] conducted a survey that analyzed the psychosocial impact of the lockdown on patients with visual impairment found that 50% of patients expressed fear of further sight loss due to delayed treatment. Few studies have proposed using a risk stratification tool to prioritize patients for cataract surgery following the pandemic,[36,37] while Bhalla et al[38] advocated for immediate sequential bilateral cataract surgery as a solution to overcome surgical backlog. Therefore, the implementation of efficient measures is fundamental to mitigating irreversible sight loss among patients affected by reduced surgical volumes during the pandemic.

Microsurgical maneuvers required for cataract surgery require a high level of training where prolonged breaks from performing surgery can lead to deterioration of the skills resulting in an increased rate of intraoperative complications.[39] Prior to the pandemic, trainees had unlimited access to the surgical wet-lab and the virtual surgical simulator, such as the Eyesi (VR, Magic AG, Mannheim, Germany), which is incorporated in the cataract surgery training curriculum for trainees to increase the safety of the procedure.[40,41] However, during the pandemic, there was restriction of wet-lab and virtual surgical stimulator usage to reduce the risk of COVID-19 transmission among trainees, this ultimately affected the outcomes of training. Hence, it is advised that trainees are subjected to intensive exposure to surgical simulators, wet labs with surgical courses on animal eyes to enhance and maintain surgical skillset before resuming cataract surgery following the pandemic.

Our study faces a number of limitations that include the retrospective nature of data review. Although this study was conducted at a single center, nevertheless, our facility is considered as one of the largest tertiary eye care hospitals in the Middle East, where judicious generalization of the results were recommended.

Our findings revealed that the MCSR declined during the pandemic, and it did not recover to baseline levels following the pandemic. The outcome of this study provides insight to key stakeholders to address the barriers to surpassing the baseline monthly rate which is crucial to eliminate the expected surgical backlog after the pandemic. Patients should be enlightened about the implemented guidelines and safety measures introduced to cataract surgery during a pandemic. Campaigns and educational material provided to patients about weighing the risks of COVID-19 related morbidity and mortality against the benefit of cataract surgery on their quality of life can be of great value. Additionally, simultaneous bilateral cataract surgeries can be an option to enhance CSR especially during a pandemic. During the pandemic, there was a notable increase in intraoperative complications which could be attributed to losing some technical skills from the prolonged surgical break especially among trainees. Hence, there is a need to improve patient safety by providing support for surgeons of all levels of expertise as they resume surgical sessions after an extended break. This can be addressed with the development of robust guidelines including perhaps mandatory time on surgical simulators. Future prospective studies should evaluate whether elective ophthalmic surgeries should be completely cancelled again over the next pandemic phases.

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Disclosure

The authors report no conflicts of interest in this work.

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