• Clinical Research •

# Intermediate impacts of COVID-19 lockdowns on surgical glaucoma cases in Quebec, Canada: insights from a tertiary eye center

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## Abstract

● **AIM:** To assess the effect of the coronavirus disease 2019 (COVID-19) pandemic on the wait times and severity of surgical glaucoma cases in a single tertiary referral center in Quebec, Canada.

● **METHODS:** Preoperative severity data included mean visual field (VF) deficit, intraocular pressure (IOP), the number of topical glaucoma medication classes, and preoperative best corrected visual acuity (BCVA). The times from referral to procedure (referral time) and from listing date to procedure (waitlisting time) were calculated.

● **RESULTS:** This retrospective cohort study involved 181 eyes of patients undergoing glaucoma surgery from March 1 to June 30, 2019 (pre-pandemic period), and 201 eyes in the same timeframe in 2021 (pandemic period) at Saint-Sacrement Hospital in Quebec City. There was no significant difference in the severity data of surgical glaucoma across both periods (VF deficit: *P*=0.48; IOP: *P*=0.14; BCVA: *P*=0.24; topical medication classes: *P*=0.27). The number of patients referred with oral glaucoma medication increased slightly from 45 to 70 in 2019 and 2021 respectively (*P*=0.08). Delay data were also comparable. Mean referral time was 122±120d in 2019 versus 144±136d in 2021 (*P*=0.09), whereas waitlisting time before the pandemic was 43±44.5 versus 39±41.8d in 2021 (*P*=0.13).

● **CONCLUSION:** Despite North America's strictest pandemic restrictions, limited negative impact is observed on waitlisting delays and the severity of glaucoma cases presenting at our center. A larger subset of patients is treated with oral medications indicating a possible increase in advanced glaucoma.

● **KEYWORDS:** glaucoma; COVID-19; glaucoma surgery; wait time

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## INTRODUCTION

Deferred eye exams and reduced intervention rates during the pandemic contributed to higher rates of vision loss[1]. Studies have reported a doubling of severe or end-stage glaucoma presentations during the pandemic, highlighting the link between delayed care and disease progression[2]. Similarly, a study conducted in South India revealed a nearly 50% increase in emergency and high-risk glaucoma patients during lockdown periods, characterized by heightened vision loss and advanced disease stages[3]. This deterioration in clinical outcomes could partly be attributed to reduced treatment adherence, which has become a global concern, driven by factors such as medication availability, travel restrictions, financial constraints, and gaps in patient knowledge[4]. These insights underscore the importance of investigating the impact of pandemic-related delays on glaucoma care and outcomes.

The diversion of medical resources to manage coronavirus disease 2019 (COVID-19) cases has strained many medical specialties[5]. Notably, the decline in ophthalmic services resulted in postponed or missed surgeries, extended waiting times, delayed interventions, and elevated risks for vision-related complications[1]. In Canada, which saw 143 000 ophthalmic surgeries postponed or canceled in the first year, the pandemic contributed to an estimated surgical delay of 31d[1]. Similarly, projection models from 2021 indicated a potential increase of 171% in patients awaiting glaucoma surgeries in Ontario in the following years[6].

The province of Quebec implemented North America's strictest public health measures to curb the spread of COVID-19 and prioritize health care access, by way of curfews, non-essential business closures, social gathering restrictions *etc*. Over two years, Quebec implemented four lockdowns, but it has also introduced multiple policies to incentivize healthcare work. These measures—met with criticism and praise—had significant public health impacts extending beyond direct pandemic control. For example, since March 15, 2020, nurse who had left their professional order for less than 5y, may begin practicing again without charge[7]. On April 2, a salary bonus of 8% to all healthcare professionals on the front line was announced, and in September, a lump-sum bonus of $15 000 was offered to new full-time nurses and $12 000 to former nurses[8-9]. Yet, the impact of these health care prioritization policies on Quebec's surgical waitlist has not been assessed. Given ophthalmology's reported high delays during COVID-19, the purpose of this study is to assess intermediate pandemic-induced disruptions in a single Quebec tertiary-center on surgical glaucoma wait times, during Quebec's strictest public health restrictions.

## PARTICIPANTS AND METHODS

**Ethical Approval** This retrospective cohort study was performed by extracting relevant data from the hospital's electronic patient records (*Dossier patient électronique,* DPE). The Director of professional services reviewed and approved the access of digitized health records on November 23, 2022 (access request dated November 16, 2022). Institutional Review Board approval was granted, and the study adhered to the tenets of the Declaration of Helsinki.

**Data Source** All patients who underwent glaucoma surgeries between March 1st and June 30, 2021 (pandemic lockdown period) and the corresponding timeframe in 2019 (pre-pandemic period) in the ophthalmology department of Saint-Sacrement hospital, Quebec City, were included. We identified and removed duplicate patient files if they appeared in both 2019 and 2021 datasets such that the natural progression of disease severity would not be a confounding factor for potential increased severity in the latter period.

The following data were collected: 1) demographic data; 2) preoperative severity data; 3) delay data. For the latter, the number of days from primary care referral to surgical procedure was extracted and referred to as "referral time", while the number of days spent on the surgical waitlist was referred to as "waitlisting time". Patients who have been followed up for more than 2y prior to the surgery were classified as known patients and their referral time data was excluded from the analysis.

**Study Period** The 2019 and 2021 study periods were chosen for representing pre-pandemic and pandemic lockdown services respectively. Indeed, spring 2021 coincided with a province-wide pandemic lockdown and the beginning of vaccination[10]. Therefore, it is a good measure of the intermediate impacts of COVID-19-related lockdowns. Furthermore, both periods had similar numbers of surgical glaucoma staff on service, which was important to our study objective as seasonal changes and other factors may cause decreased patient volumes and increased delays[11-13]. Controlling for the number of staff minimizes non-COVID-related causes of decreased patient volumes.

**Statistical Analysis** Statistical analyses were performed using Microsoft Excel. Continuous variables were presented as means and standard deviations (SD) unless otherwise stated. Categorical variables were expressed as frequencies and percentages. Significant differences between 2019 and 2021 data were assessed using Pearson Chi-square tests for categorical variables, and Student's *t*-test for continuous variables. Statistical significance was set a $P<0.05$.

## RESULTS

**Demographics** A total of 382 eyes were included in this study, with 181 eyes from 2019 and 201 eyes from 2021. Table 1 summarizes the demographic data of the glaucoma cases studied. Both groups had comparable characteristics, and most differences were non-statistically significant. The mean age at surgery was slightly higher in 2021 (73.4±11.3y) than 2019 (70.8±13.0y). Gender distribution was similar before and during the pandemic, with a general 1:1 male to female ratio. During both periods, about a third of the operated patients had already received prior glaucoma surgery in the same eye (2019: $n$=52, 28.7%; 2021: $n$=54, 26.9%; $P$=0.73), and about a quarter of individuals had a positive family history of glaucoma (2019: $n$=41, 22.7%; 2021: $n$=53, 26.4%, $P$=0.47). Out of all types of glaucoma, primary open angle glaucoma (POAG) was the most prevalent diagnosis throughout both timeframes, accounting for up to two-thirds of total cases (2019: $n$=100, 55.2%; 2021: $n$=132, 65.7%; $P$=0.19). Furthermore, a statistically significant decrease in secondary glaucoma cases was observed during the pandemic, representing 29.3% ($n$=53) of all cases in 2019 and 18.9% ($n$=38) of all cases in 2021 ($P$=0.04). Other types of glaucoma remained consistent as reported in Table 1.

**Glaucoma Surgeries Conducted** Overall, 194 surgeries were conducted in 2019, and 204 interventions were performed in 2021. As shown in Figure 1, the three most common procedures were trabeculectomy (2019: $n$=84, 43%; 2021: $n$=88, 37%; $P$=0.80), Baerveldt implant surgery (2019: $n$=36, 19%; 2021: $n$=40, 17%; $P$=0.93), and diode laser cyclophotocoagulation (2019: $n$=34, 18%; 2021: $n$=35, 15%; $P$=0.82). Other surgical procedures included, in order of frequency, revision cases (2019: $n$=13, 7%; 2021: $n$=18, 8%; $P$=0.51), Ahmed

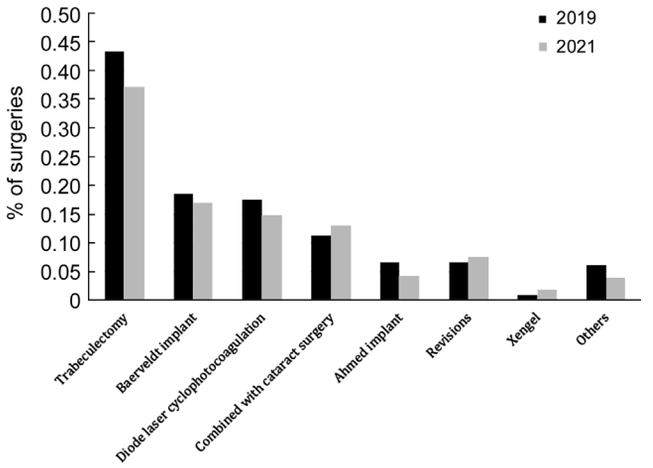


**Figure 1 Types of glaucoma surgeries performed during the pre-pandemic and pandemic periods.**

**Table 1 Demographic data of the study population**

| Baseline characteristics | 2019 | 2021 | *P* |
|---|---|---|---|
| No. of eyes (*n*) | 181 | 201 | |
| Age (y) | 70.8±13.0 | 73.4±11.3 | 0.02 |
| Males, *n* (%) | 92 (50.8) | 100 (49.8) | |
| Previous glaucoma surgery in the same eye, *n* (%) | 52 (28.7) | 54 (26.9) | 0.73 |
| Family history of glaucoma, *n* (%) | 41 (22.7) | 53 (26.4) | 0.47 |
| OD, *n* (%) | 90 (49.7) | 80 (39.8) | |
| Type of glaucoma, *n* (%) | | | |
| Open angle | 100 (55.2) | 132 (65.7) | 0.19 |
| Closed angle | 5 (2.8) | 7 (3.5) | 0.69 |
| Secondary | 53 (29.3) | 38 (18.9) | 0.04 |
| Mixed | 18 (9.9) | 20 (10.0) | 1.00 |
| Juvenile | 5 (2.8) | 3 (1.5) | 0.39 |
| Others | 0 | 0 | |
| Not available | 0 | 1 (0.5) | 0.35 |

OD: *Oculus dexter*.

implant surgery (2019: *n*=13, 7%; 2021: *n*=10, 4%; *P*=0.41), other surgeries such as goniosynechialysis, goniotomy, and gonioscopy-assisted transluminal trabeculotomy (GATT; 2019: *n*=12, 6%; 2021: *n*=9, 4%; *P*=0.40), and Xengel implants (2019: *n*=2, 1%; 2021: *n*=4, 2%; *P*=0.48). Additionally, the number of glaucoma surgeries combined in the same sitting with phacoemulsification were comparable across both periods (2019: *n*=22, 11%; 2021: *n*=31, 13%, *P*=0.35). There were no statistically significant differences in the numbers and types of surgeries conducted between 2019 and 2021.

**Severity of Surgical Glaucoma Cases** Table 2 provides an overview of the variables assessing the severity of surgical glaucoma cases in 2019 versus in 2021. An elevated intraocular pressure (IOP) stands as the principal risk factor influencing the progression of the disease. In our study, IOP at referral did not significantly differ before and during the pandemic: in 2019, the mean IOP at referral was 23.3±10.7 mm Hg while

**Table 2 Severity data of surgical glaucoma cases in 2019 and 2021**

| Parameters | 2019 | 2021 | *P* |
|---|---|---|---|
| Referral IOP (mm Hg) | 23.3±10.7 | 22.8±10.9 | 0.36 |
| Preoperative IOP (mm Hg) | 21.1±9.7 | 20.0±9.5 | 0.14 |
| Use of oral glaucoma medication, *n* (%) | 45 (25) | 70 (35) | 0.08 |
| RNFL (μm) | 64.7±18.1 | 65.2±15.1 | 0.42 |
| VF mean deviation (dB) | -11.6±7.7 | -11.6±7.4 | 0.48 |
| Glaucoma severity, *n* (%) | | | |
| Normal | 11 (9) | 9 (6) | 0.37 |
| Mild | 24 (19) | 26 (18) | 0.78 |
| Moderate | 36 (28) | 50 (34) | 0.39 |
| Advanced | 34 (27) | 43 (29) | 0.65 |
| Severe | 23 (18) | 18 (12) | 0.21 |
| Central VF deficit, *n* (%) | 104 (57) | 115 (57) | 0.98 |
| BCVA (logMAR) | 0.60±0.73 | 0.55±0.73 | 0.24 |
| Preoperative number of glaucoma agents (*n*) | 3.0±1 | 2.9±1 | 0.27 |
| Postoperative number of glaucoma agents (*n*) | 1.5±2 | 1.5±1 | 0.40 |

BCVA: Best corrected visual acuity; IOP: Intraocular pressure; RNFL: Retinal nerve fiber layer; VF: Visual field.

in 2021, it was 22.8±10.9 mm Hg (*P*=0.36). No significant difference in preoperative IOPs was observed either (2019: 21.1±9.70; 2021: 20.0±9.5 mm Hg; *P*=0.14).

The retinal nerve fiber layer (RNFL) tends to be significantly thinner in glaucomatous eyes and correlates with disease severity[14]. In our study, the mean RNFL thickness was 64.7±18.1 μm in 2019 and 65.2±15.1 μm in 2021, a difference which was not statistically significant (*P*=0.42). There was no statistically significant difference in mean visual field (VF) loss between 2019 (-11.6±7.7 dB) and 2021 (-11.6±7.4 dB, *P*=0.48). In both groups, more than half of operated patients presented with central VF deficit at the time of surgery. The preoperative best corrected visual acuity (BCVA) remained unchanged in 2019 (0.60±0.73 logMAR) and 2021 (0.55±0.73 logMAR, *P*=0.24).

Eye drops constitute the first line of treatment for glaucoma in North America, and the number of different classes used per patient can give an indication of the severity of the disease. In the present study, the mean number of classes of eye drops used per patient preoperatively (2019: 3.0±1 classes; 2021: 2.9±1 classes; *P*=0.27) and postoperatively (2019: 1.5±2 classes; 2021: 1.5±1 classes; *P*=0.40) did not significantly differ before and during the pandemic era. On the flipside, an increase in the number of patients having had oral glaucoma medication (acetazolamide) was observed, going from 45 in 2019 to 70 in 2021 (*P*=0.08). There was no statistically significant difference in the numbers and types of topical medications classes prescribed in this study, as shown in Table 3.

**Surgical Wait Times** The time spent on waiting lists and delays in the referral process are crucial to consider in patient care, as these factors can have an impact on surgical outcomes. In 2019, 181 waitlisted patients and 130 referred patients had

available delay data and were included in the analysis. In 2021, this number was 201 and 147 respectively. As illustrated in Table 4, referral time did not significantly differ between 2019 (122±120d) and 2021 (144±136d, *P*=0.09). Figure 2 illustrates waitlisting delay breakdowns for the two periods. Waitlisting time was also comparable in the intermediate stage of COVID-19 outbreak (2019: 43.0±44.5d; 2021: 39.0±41.8d; *P*=0.13). As illustrated in Table 5, urgent and elective surgeries in both 2019 and 2021 had comparable waitlisting delays.

## DISCUSSION

The COVID-19 pandemic has put a serious strain on healthcare centres' ability to offer elective services and treat chronic diseases in a timely manner. The purpose of this study was to determine the intermediate impact of COVID-19 on the severity and wait times of surgical glaucoma cases at a tertiary ophthalmic care center in Quebec City, Canada. Among a total of 382 eyes analyzed, severity criteria, including pre-operative IOP, BCVA, number of eyedrop classes, and surgical delays remained comparable between the pre-pandemic and intermediate pandemic periods.

Longo *et al*[2] examined the effects of COVID-19 on glaucoma surgery in the initial year following the emergence of the disease and documented a 30.1% decrease in surgical volume compared to 2019. More broadly, 77%–90% reductions of the usual volume of ophthalmic surgeries performed have been observed at other tertiary ophthalmic surgical centres in North America and Europe[6]. As per the results of the present study, the numbers of patients operated during the first quarters of 2019 and 2021 were similar: 194 surgeries were conducted in 2019, versus 204 in 2021, indicating an increase of 5% in surgical volume during the pandemic. The proportions of each type of surgery performed were not affected either: trabeculectomy, Baerveldt implant surgery, and laser procedures were the most common interventions before and during the pandemic. The increased number of patients receiving Xen gel stents in 2021 can be attributed to the adoption of the treatment in the hospital during the latter period. These results contradict expected findings, as Holland *et al*[15] report that 43% of surgeons surveyed in their study reduced the number of trabeculectomies performed subsequently to COVID-19. Diode laser was alternatively used, mainly because it required less postoperative follow-up. However, not all tertiary centers reported a decrease in the number of interventions during COVID-19: Quaranta *et al*[16] reported an increase in the number of glaucoma procedures performed due to service closures in suburban hospitals. Longo *et al*[2] further reported a significant increase in surgical activity during the second quarter of the pandemic (April 2020-June 2020), a finding which coincided with the reduction in COVID-19 hospitalizations in Italy and the restauration of regular availability of operating rooms and staff. It could be for a similar reason that there were no less surgeries performed in 2021 than in 2019 in the current study, as the initial wave of hospitalizations had already occurred in 2020 and operating rooms were back to full capacity.

Given the impact of the COVID-19 pandemic, ophthalmology departments in several countries across Europe and Asia have delayed a significant proportion (57% to 100%) of their

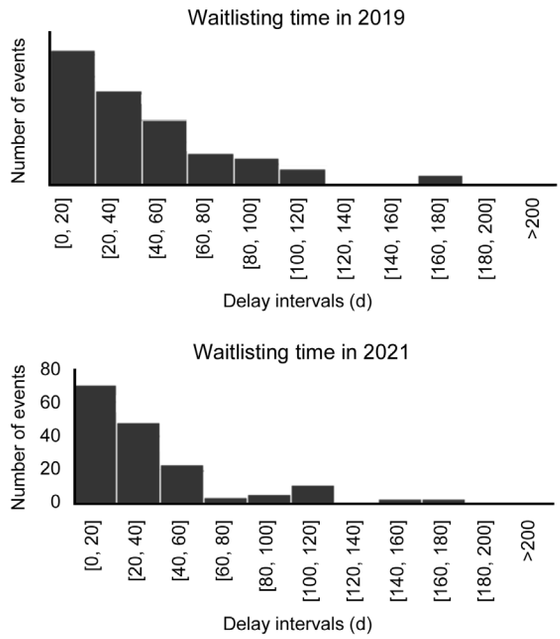


**Figure 2 Waitlisting delay distributions in 2019 and 2021.**

**Table 3 Types of topical glaucoma medications prescribed in 2019 and 2021** *n* (%)

| Classes of medication | 2019 | 2021 | *P* |
|---|---|---|---|
| Prostaglandins | 149 (28) | 168 (29) | 0.66 |
| Alpha-adrenergics | 103 (19) | 93 (16) | 0.23 |
| Beta-blockers | 140 (26) | 147 (25) | 0.86 |
| Carbonic anhydrase inhibitors | 136 (25) | 155 (27) | 0.60 |
| Mitotics/cholinergics | 10 (2) | 14 (2) | 0.52 |

**Table 4 Wait times of surgical glaucoma cases in 2019 and 2021**

| Wait times | 2019 | 2021 | *P* |
|---|---|---|---|
| Referral time (d) | 122±120 | 144±136 | 0.09 |
| Waitlisting time (d) | 43.0±44.5 | 39.0±41.8 | 0.13 |

**Table 5 Comparison of desired and actual waitlisting delays according to procedure booking forms**

| Waitlisting priorities | Actual delay (d) | | *P* |
|---|---|---|---|
| | 2019 (*n*=117) | 2021 (*n*=153) | |
| Urgent | | | |
| Less than 24h | 1.0±1 | 0.4±1 | 0.12 |
| Elective | | | |
| P1 (less than 2wk) | 19.0±12 | 13.3±10 | 0.07 |
| P2 (less than 4wk) | 38.6±24 | 33.6±17 | 0.14 |
| P3 (less than 12wk) | 57.7±59 | 59.4±39 | 0.41 |
| P4 (elective) | 55.3±87 | 87.3±84 | 0.18 |

glaucoma treatments[17-22]. A decrease in surgical volume is directly related to longer wait times for patients. As a direct consequence of COVID-19, the estimated mean wait time for patients across ophthalmic subspecialty surgeries increased from 94±97 in 2019 to 282±91d in March 2023 in the province of Ontario[6]. Interestingly, surgical delays were not significantly affected by the pandemic measures in the present study. Incidentally, it was noted that in 2019, many patients deferred surgeries because the proposed date conflicted with winter travel plans, which possibly artificially lengthened wait times. Indeed, winter migration to warmer regions ("snowbirding") is a popular custom among older Quebec residents, our study population[23]. Travel bans during the pandemic could have contributed to shortened waitlisting time in 2021 by eliminating this patient-related factor but may also explain the lack of observed differences if any pandemic-related delays were present[24]. Furthermore, the pandemic catalyzed the adoption of virtual clinics[25]. The Canadian government announced on May 3, 2020, the Canada-Quebec Agreement on Virtual Care in Response to COVID-19, where federal funding of almost $29 millions out of $150 millions flowed to support virtual consults in Quebec. This prioritization of virtual care was another protecting factor that ensured at-risk patients received timely medical care in Quebec[26]. It was noted that there were no changes in this hospital's allocation of operating days for glaucoma surgeries but that glaucoma specialists generally prioritized glaucoma procedures over cataracts during the pandemic period. No significant referral delays from primary healthcare providers (family doctor or optometrist) were noticed.

More severe cases at presentation may indicate poorer access to medical care. An Indian study reported an increase of 48.9% and 48.4% of the number of high-risk patients and new cases presenting as emergencies respectively, compared to figures from 2019[3]. The severity of cases was not affected in the present study. Indeed, IOP at referral, preoperative IOPs, RNFL thickness, VF loss, and preoperative BCVA did not significantly differ between 2019 and 2021. In fact, multiple findings in the present study contradict the findings of other studies on the matter, which report an increase of mean IOP, VF loss, and worse BCVA during COVID-19[3,27-28]. Furthermore, ophthalmology departments from various nations have postponed a substantial proportion of glaucoma treatments, contrary to what is observed in the current study[18,21]. These differences might be explained by multiple factors. First, our institution prioritized surgical cases. Thus, while non-surgical cases might've been impacted in the region, surgical cases were not, leading to no differences in wait time and preoperative characteristics and between 2019 and 2021. Other studies that compared BCVA and IOP of patients before and during the pandemic might've taken into account non-surgical cases[3], for which nonadherence to treatment was prevalent during COVID-19[29]. Furthermore the types of surgical procedures practiced during COVID-19 did not change significantly. Before COVID-19, trabeculectomy was the preferred technique for treating glaucoma in multiple countries[15-16]. However, during the pandemic, there was a decline in the number of trabeculectomies performed elsewhere from Quebec. Instead, micropulse and traditional transscleral cyclodiode procedures became the most commonly used alternatives[3,15]. As the procedures practiced in our region stayed the same, the patient criteria for qualifying for surgery also remained consistent. A study analyzing ophthalmology referrals between the COVID-19 pandemic and the prepandemic era in Vancouver, Canada indicated that while tertiary care centers designated as COVID treatment "hot spots" experienced a significant decline in referrals, community hospitals with lower COVID exposure did not see a similar reduction[30]. Interestingly enough, referrals from non-emergency outpatient clinics significantly increased during this period[30]. It is important to highlight that our center serves as the sole tertiary referral center for glaucoma care in Northern and Eastern Quebec. This unique role allows for a comprehensive assessment of the longer-term impact of the pandemic on surgical glaucoma management. During the pandemic, our institution prioritized glaucoma surgeries to mitigate the potential after-effects of pandemic-related restrictions. By implementing proactive measures and maintaining glaucoma as a high-priority service, we ensured continuity of care and minimized disruptions in surgical volume and patient outcomes. In addition, some studies may have reported longer waiting times and worse preoperative characteristics because the periods in which they collected patient data coincided with different phases of the pandemic from the one in this study. Indeed, Rajendrababu *et al*[3] conducted their study between March 2020 and June 2020 for their COVID-19 subgroup, right at the time of the first COVID-19 wave for which hospitals had to face the pandemic for the first time. The increased use of oral glaucoma medication during the pandemic may have also contributed to the consistency in preoperative patient characteristics across the two timeframes; effectively controlling disease progression in small subsets of higher severity patients during the 2021 pandemic period. The relationship between physicians' perception of medical care delays and the prescription of stronger oral glaucoma medication would be an interesting topic to be explored in future studies.

The current study has some limitations. It is correlational and does not draw causative outcomes between pandemic measures, glaucoma severity, and surgical delays. Only operated patients were included, meaning changes in waitlists'

sizes and intervention cancellations due to patient-related factors could not be accounted for. Being a monocentric study, some pre-operative data may be missing or limited, due to follow-up in local ophthalmology clinics. Additionally, we acknowledge that a longer study period, capturing multiple waves of the pandemic, would provide a more comprehensive understanding of the long-term effects on glaucoma care. While the study has its limitations, it provides valuable insights into the resilience and adaptability of the healthcare system in managing glaucoma cases during the COVID-19 pandemic. The study samples from the sole tertiary ophthalmic reference center in Northern and Eastern Quebec. As such, results reflect the general status of ophthalmic services in a broad region in Quebec. Several severity outcomes were measured, drawing a robust picture of disease severity amidst the initial impact of COVID-19. The unexpected waiting list delays and the maintenance of surgical volume underscore the importance of adaptation of healthcare practices in response to external challenges.

This study found no differences in the disease severity and delays amongst patients operated for glaucoma in the intermediate stage of the pandemic in a Quebec tertiary hospital. The COVID-19 pandemic considerably disrupted health care and management, leading to delayed interventions, worsened disease outcomes, and compromised patient well-being over a wealth of medical specialties. Evaluating surgical glaucoma severity and treatment delays sheds light the importance of clinical practices and policies to ensure the continued provision of quality eye care services in times of crisis. Further studies incorporating longer timeframes, including non-surgical glaucoma referrals, and examining province-wide postoperative ophthalmic outcomes of the pandemic will help us build resilient policies to better face similar public health issues in the future.

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**Conflicts of Interest: Zhang H,** None; **McIntyre S,** None; **Er-reguyeg Y,** None; **Toren A,** None.

**REFERENCES**

1 Deloitte Access Economics. Addendum to the cost of vision loss and blindness in Canada: the impact of COVID-19. Canadian Council of the Blind; 2021. https://ccbnational.net/shaggy/wp-content/uploads/2023/07/9-Deloitte-COVID-Addendum-Acc-August-2021.pdf

2 Longo R, Franzolin E, Pedrotti E, *et al*. Glaucoma surgery during the first year of the COVID-19 pandemic. *Int Ophthalmol* 2022;42(9):2881-2887.

3 Rajendrababu S, Durai I, Mani I, *et al*. Urgent and emergent glaucoma care during the COVID-19 pandemic: an analysis at a tertiary care hospital in South India. *Indian J Ophthalmol* 2021;69(8):2215-2221.

4 Yadav M, Tanwar M. Impact of COVID-19 on glaucoma management: a review. *Front Ophthalmol* 2022;2. https://www.frontiersin.org/articles/10.3389/fopht.2022.1003653

5 Brant LCC, Pinheiro PC, Machado IE, *et al*. The impact of COVID-19 pandemic course in the number and severity of hospitalizations for other natural causes in a large urban center in Brazil. *PLoS Glob Public Health* 2021;1(12):e0000054.

6 Felfeli T, Ximenes R, Naimark DMJ, *et al*. The ophthalmic surgical backlog associated with the COVID-19 pandemic: a population-based and microsimulation modelling study. *CMAJ Open* 2021;9(4):E1063-E1072.

7 Québec OIIQ. COVID-19: The OIIQ will facilitate the return to the nursing profession. 2020. https://web.archive.org/web/20230625164051/https://www.newswire.ca/fr/news-releases/covid-19-l-oiiq-facilitera-le-retour-a-la-profession-infirmiere-841833665.html

8 Quebec to offer nurses bonuses of up to $18K to end staffing crisis | CBC News. 2022. https://web.archive.org/web/20250522191237/https://www.cbc.ca/news/canada/montreal/quebec-plan-nursing-staffing-crisis-1.6186971

9 Radio-Canada. COVID-19 bonuses of 8% or 4% for healthcare workers in Quebec | COVID-19: everything about the pandemic. 2020. https://ici.radio-canada.ca/nouvelle/1690608/coronavirus-primes-sante-dube-mccann-annonce

10 INSPQ. COVID-19 timeline in Quebec | National Institute of Public Health of Quebec. 2022. https://www.inspq.qc.ca/covid-19/donnees/ligne-du-temps

11 Spencer E, Berry M, Martin P, *et al*. Seasonality in surgical outcome data: a systematic review and narrative synthesis. *Br J Anaesth* 2022;128(2):321-332.

12 Liu L. Determining the bias in waiting times reported by the Ontario joint replacement registry. *Digit Theses* 2008. https://ir.lib.uwo.ca/digitizedtheses/4180

13 Zangbar B, Rhee P, Pandit V, *et al*. Seasonal variation in emergency general surgery. *Ann Surg* 2016;263(1):76-81.

14 Bowd C, Weinreb RN, Williams JM, *et al*. The retinal nerve fiber layer thickness in ocular hypertensive, normal, and glaucomatous eyes with optical coherence tomography. *Arch Ophthalmol* 2000;118(1):22-26.

15 Holland LJ, Kirwan JF, Mercieca KJ. Effect of COVID-19 pandemic on glaucoma surgical practices in the UK. *Br J Ophthalmol* 2022;106(10):1406-1410.

16 Quaranta L, Micheletti E, Riva I. Glaucoma surgery during the COVID-19 pandemic in Italy: how novel coronavirus has changed the surgical management of glaucoma patients. *J Glaucoma* 2020;29(10):831-832.

17 Romano MR, Montericcio A, Montalbano C, *et al*. Facing COVID-19 in ophthalmology department. *Curr Eye Res* 2020;45(6):653-658.

18 Young BE, Ong SWX, Kalimuddin S, *et al*. Epidemiologic features and clinical course of patients infected with SARS-CoV-2 in Singapore. *JAMA* 2020;323(15):1488-1494.

19 Lipsitch M, Cohen T, Cooper B, *et al*. Transmission dynamics and control of severe acute respiratory syndrome. *Science* 2003;300(5627): 1966-1970.

20 Wallinga J, Teunis P. Different epidemic curves for severe acute respiratory syndrome reveal similar impacts of control measures. *Am J Epidemiol* 2004;160(6):509-516.

21 Toro MD, Brézin AP, Burdon M, *et al*. Early impact of COVID-19 outbreak on eye care: insights from EUROCOVCAT group. *Eur J Ophthalmol* 2021;31(1):5-9.

22 Pomara C, Li Volti G, Cappello F. COVID-19 deaths: are we sure it is pneumonia? Please, autopsy, autopsy, autopsy! *J Clin Med* 2020;9(5):E1259.

23 Roy MP. Cross-border issues for snowbirds and roving retirees. *Estates Trusts Pensions J* 2006;26:116.

24 Blondeau H. Québec French in Florida: North American francophone language practices on the road. *J Transnatl Am Stud* 2017;8(1). https://escholarship.org/uc/item/7n0746bk

25 Hardcastle L, Ogbogu U. Virtual care: enhancing access or harming care *Healthc Manage Forum* 2020;33(6):288-292.

26 Canada-Quebec Agreement on Virtual Care in Response to COVID-19. 2021; https://www.canada.ca/en/health-canada/corporate/transparency/health-agreements/canada-quebec-agreement-virtual-care-response-covid-19.html

27 Bala DS, Islam DSM, *et al*. Impact of COVID19 pandemic on visual field loss in glaucoma patients with irregular follow-up and medication adherence at a tertiary eye care centre in eastern India. *World J Pharm Med Res* 2022;8(8). https://www.wjpmr.com/abstract/4385

28 Barış ME, Çiftçi MD, Güven Yılmaz S, *et al*. Impact of COVID-19-related lockdown on glaucoma patients. *Turk J Ophthalmol* 2022;52(2):91-95.

29 Subathra GN, Rajendrababu SR, Senthilkumar VA, *et al*. Impact of COVID-19 on follow-up and medication adherence in patients with glaucoma in a tertiary eye care centre in south India. *Indian J Ophthalmol* 2021;69(5):1264-1270.

30 Schlenker A, Tadrous C, Ching G, *et al*. Retrospective analysis of ophthalmology referrals during the COVID-19 pandemic compared to prepandemic. *Can J Ophthalmol* 2021;56(4):217-222.