


Influence of COVID-19 on the Prognosis and Medication Compliance of Glaucoma Patients in the Nile Delta Region

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Objective: To assess the influence of the COVID-19 pandemic on the medication adherence and follow-up of glaucoma patients in the Nile Delta region.

Setting: A tertiary care center in the Nile Delta region, Egypt.

Study Design: An observational, cross-sectional study.

Participants: Patients' records (2019–2020; group A) and (2020–2021; group B) were assessed for missed follow-up visits, medication adherence, number of trabeculectomies performed, and uncontrolled patients. In addition, a telephone-based questionnaire involving randomly chosen 200 patients from B.G.U. was carried out to clarify the potential causes of poor patients' compliance.

Results: There was a marked decline in the number of newly diagnosed patients and patients on regular follow-up with incidence rates 0.208 and 0.088 in group (A) and group (B), respectively (P -value < 0.0001). The number of compliant patients in group B decreased with an incidence rate difference of 0.312. The number of trabeculectomies declined in group (B) with an incidence rate in group (A) 0.131 compared to 0.081 in group (B). On the other hand, the number of uncontrolled glaucoma patients increased in group B with an incidence rate difference -0.231 between the two groups. 21.5% of patients who participated in the questionnaire identified financial issues as the leading cause of non-compliance. Comorbidities (19.5%), lockdown and transportation difficulties were also highlighted.

Conclusion: COVID-19 had greatly hampered glaucoma care in the Nile Delta region. As a result, we need to implement new technologies like telemedicine and improve patients' awareness of glaucoma care. Training orthoptists and using mobile glaucoma care services would also be helpful ways of managing glaucoma during that pandemic.

Keywords: COVID-19, glaucoma, compliance, follow-up, questionnaire

Introduction

The World Health Organization (WHO) declared COVID-19 as a global pandemic on March 11, 2020.¹ Egypt identified the first COVID-19 case on February 13, 2020. Since then, numbers of confirmed cases, convalescent individuals, and deaths related to COVID-19 infection soared.² Hospitals were overwhelmed by a massive number of patients, which necessitated strict guidelines and precautions to avoid the collapse of the medical service.³ Those precautions gave priority to emergency cases to ease pressure over the hospitals. Patients with chronic diseases were advised to decrease the number of hospital visits and to use remote consultation for follow-up like phone or video calls.⁴

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Glaucoma is a chronic ocular disease that affects nearly 2% of Egyptians in the urban population and 9% in rural areas.⁵ Regular and careful follow-up is crucial for this potentially blinding disease.⁶ Glaucoma patients' follow-up visits were significantly affected by the new regulations adopted by hospitals in the fight of COVID-19.^{2–4} Several studies showed that nearly 50% of glaucoma patients are not adherent to their glaucoma medications over 75% of the time.⁷ This figure is expected to get worse in the time of the pandemic.⁸

Benha Glaucoma Unit (B.G.U.) is a specialized unit in Benha University Hospitals dedicated to screening, treating, and following glaucoma patients. That unit is receiving patients from various governorates in the heavily populated Nile Delta region. In this study, we aimed to assess the impact of the COVID-19 pandemic on glaucoma patients in the Nile Delta region in terms of adherence to follow-up, medications, and overall prognosis.

Methods

We performed an observational cross-sectional study on patients attending B.G.U., Benha University Hospital, a referral tertiary care center to Egypt's Nile Delta region, between March 2019 and March 2021. Data collection was approved by the regional institutional ethics review board of Benha University Hospital. In addition, the board waived the requirement to obtain patients' consent to review participating medical records due to the study's retrospective nature. Patient data remained confidential in compliance with HIPAA regulations and the Declaration of Helsinki.

All patients included in this study were 18 years old and above with a diagnosis of glaucoma confirmed by Intra-Ocular Pressure (I.O.P.) measurement, visual field assessment, and fundus examination. We went through the medical records registry at the information technology unit in B.G.U to retrieve details about glaucoma patients under follow-up. Patients with incomplete records, cataract surgery, or other surgery which might influence routine glaucoma care and frequency of follow-up and those who shifted follow-up to other glaucoma units were excluded. Medical records from March 2019 to February 2020 before the widespread of COVID-19 were compared to records from March 2020 to February 2021. Out of 4132 recorded cases from the first year, we excluded 343 patients with incomplete records, 989 cases with previous surgery, and 46 subjects switched to other glaucoma units, so 2754 cases were included from this group. In the second group, the total number of recorded patients was 2313 cases. We excluded 86 cases with

incomplete records, 623 cases with previous surgery, and 32 subjects who shifted to other glaucoma units, so 1572 cases were included from this group. Patients' data included the number of newly diagnosed glaucoma patients, number of patients on regular follow-up (at least four times per year), number of compliant patients on medical treatment, number of patients who underwent surgical operations, and the number of uncontrolled glaucoma patients.

Procedures and Evaluation

All patients were diagnosed with glaucoma based on standard clinical assessment and criteria. Corrected distance visual acuity was measured in the outpatient clinic using Snellen's chart. I.O.P. was measured by the Goldmann applanation tonometer. Anterior segment evaluation was performed using slit lamp, and the anterior chamber angle was assessed using Goldmann 3-mirror contact lens. The cup-to-disc ratio (C.D.R.) was estimated using slit lamp biomicroscopy for all patients in each follow-up visit. Visual field 24–2 (Humphrey Field Analyzer, Zeiss medical technology, USA) and Optical Coherence Tomography (OCT) (Topcon Corporation, Japan) of Optic Nerve Head (O.N.H.), Retinal Nerve Fiber Layer (RNFL), and Ganglion Cell Complex (G.C.C.) were obtained at each follow-up visit. Data of other ocular and systemic comorbidities were also extracted.

Missing at least one dose of glaucoma medications two days a week was considered non-compliance. We depended on self-reporting by patients to detect missed doses. In addition, a change of -1 dB or more in Mean Deviation (M.D.) per year in the patient's visual field was defined as uncontrolled glaucoma. Visual fields were done regularly every three months for all patients.

A questionnaire was prepared and discussed with patients over the phone to clarify the causes of missed hospital follow-up visits and obstacles in patients' medication compliance. A random sample of 200 patients was selected from B.G.U patients' records for 2020–2021. Verbal consent was obtained from patients to participate in the questionnaire before asking questions. Patients were excluded from the questionnaire if they refused to participate or did not answer their phones. Patients who accepted participating in the questionnaire were asked to identify a single main reason for non-compliance with their glaucoma medications.

Statistical Analysis

Statistical analysis was performed using SPSS (version 13, SPSS Inc., Chicago, IL). All results were presented as mean values \pm standard error of the mean.

Table 1 Demographic Criteria of Study Groups

Group	Age (Years) Mean \pm S.D.	Gender	
		Male	Female
A	61 \pm 4.5	1258	1496
B	60 \pm 5	753	819

Patient and Public Involvement

No patient or public was involved in the study.

Ethics Approval Statement

This study was approved by the Institutional Review Board of Benha University Hospital (Reference number RC7-9-2021).

Results

This is an observational cross-sectional study to assess the flow of patients, compliance with medications, and adherence to follow-up visits in B.G.U. We ran through patients' records attending B.G.U. and divided them into two groups. The first group (A) included patients' records between March 2019 and February 2020, while the second group (B) included records from March 2020 to February 2021. There were no statistically significant differences between both study groups regarding patients' age and gender (Table 1). Newly diagnosed glaucoma patients were 573 out of 2754 in group (A). This number

plunged to 139 out of 1572 in group (B), with incidence rates 0.208 and 0.088 in group (A) and group (B), respectively (Figure 1). The incidence rate difference was 0.12, which was statistically significant with P-value < 0.0001 (Table 2).

In group (A), 1469 patients were compliant with their glaucoma eye drops, compared to only 348 patients in group (B). That made an incidence rate 0.533 and 0.221 in groups (A) and (B), respectively, with an incidence rate difference 0.312, which was statistically significant with P-value < 0.0001 (Table 3, Figure 2).

Trabeculectomy surgery was performed on 361 patients in group (A), compared to only 128 patients in group (B). The incidence rate of those cases in group (A) was 0.131 compared to 0.081 in group (B), with an incidence rate difference 0.05. That was statistically significant with P-value < 0.0001 (Table 4, Figure 2).

As regards uncontrolled glaucoma cases, the incidence rate of these cases in group (A) was 0.203 (560 patients) compared to 0.434 (682 patients) in group (B) with an incidence rate difference -0.231 with P-value < 0.0001 (Table 5, Figure 2).

Out of 200 non-compliant cases addressed by the questionnaire, 182 patients were reachable and accepted to participate in our questionnaire to determine the causes of non-compliance. The main reason was financial difficulties which represented 21.5% of these cases. The second cause was patients' illness other than

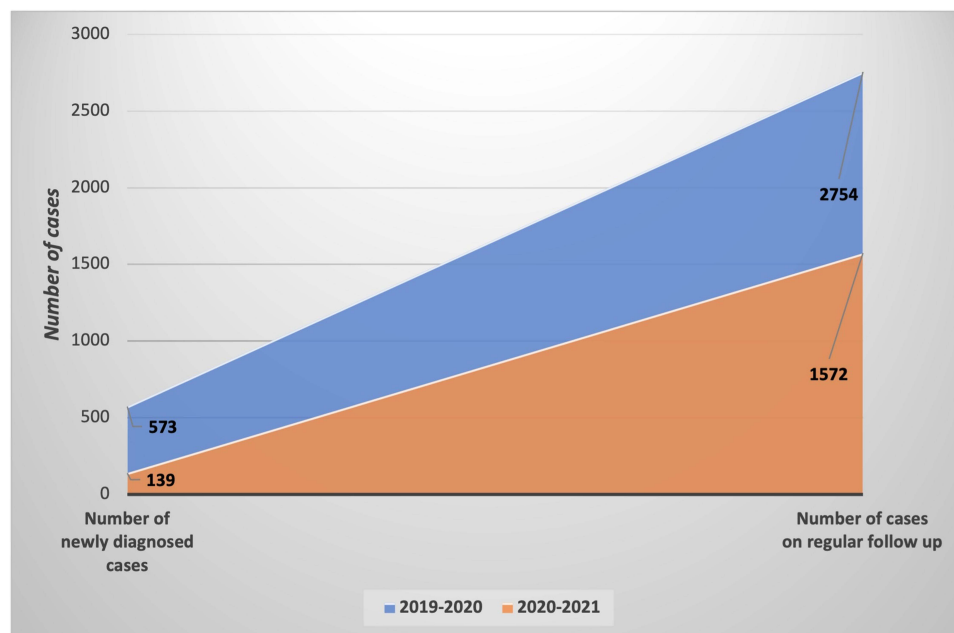
**Figure 1** Number of new cases and cases on regular follow-up.

Table 2 Number of Newly Diagnosed Cases

Incidence	Value
[2019–2020] incidence rate	0.208
95% CI	0.1914 to 0.2258
[2020–2021] incidence rate	0.088
95% CI	0.07433 to 0.1044
Incidence rate difference	0.120
95% CI	0.0945 to 0.1448
P-value	P < 0.0001
Incidence rate ratio	2.353
95% CI	1.9518 to 2.8529

Table 3 Number of Compliant Cases on Medical Treatment

Incidence	Value
[2019–2020] incidence rate	0.533
95% CI	0.5065 to 0.5614
[2020–2021] incidence rate	0.221
95% CI	0.1987 to 0.2459
Incidence rate difference	0.312
95% CI	0.2719 to 0.3522
P-value	P < 0.0001
Incidence rate ratio	2.410
95% CI	2.1423 to 2.716

glaucoma (including COVID-19), and this item represented 19.5% of cases, while the third one was lockdown and transportation difficulties (Table 6 and Figure 3).

Discussion

COVID-19 pandemic has changed the way healthcare organizations offer their services.^{9,10} The pressure over healthcare services to accommodate the hectic rise in the number of patients needing hospitalization and the highly contagious nature of the virus had detrimental effects on patients with chronic diseases who need regular follow-up and close observation.^{11,12}

Amid fears of national health catastrophe, governments had implemented various restrictions like lockdown, self-quarantine, night curfew, and social distancing. Those

restrictions were expected to affect vulnerable people, especially those with chronic diseases.¹³

Glaucoma is a chronic eye disease that needs efficient and regular follow-up to avoid its potentially blinding effect.^{5–7} Poor compliance and adherence to medications are well-known drawbacks for glaucoma patients, especially in Africa.¹⁴

Mahmoud H¹⁵ did an internet-based questionnaire including Egyptian ophthalmologists to assess the effect of COVID-19 on ophthalmology practice in Egypt. 81.5% of participants (1257 ophthalmologists) thought that the lockdown had a deleterious impact on the progression and follow-up of chronic diseases (eg, glaucoma).

Our study targeted glaucoma patients served by B.G.U. to evaluate the change in healthcare offered by our unit amid the unprecedented COVID-19 pandemic. We found a remarkable decline in the number of patients attending B.G.U., either newly diagnosed or on regular follow-up, in the year (2020–2021) when COVID-19 cases were soaring (Figure 1). Interestingly, the number of trabeculectomies plunged as well, from 361 eyes in group (A) to 128 in group (B). The newly adopted hospital regulations prioritizing emergency surgeries over elective ones could explain the drop in the number of glaucoma surgeries.

On the other hand, the numbers of non-compliant patients who were not compliant with their glaucoma medications were significantly higher in group (B) than group (A). That was reflected in the number of poorly controlled cases which increased from 560 in group (A) to 682 in group (B).

We analyzed the possible causes of that dramatic change in healthcare provided by B.G.U. in 2020–2021 by launching a telephone-based questionnaire with our glaucoma patients. Financial issue (21.5% of participants) was the first and most awkward barrier against adherence to medications and attending regular follow-ups. That could be explained by the enormous economic burden of the pandemic over the Egyptian economy.¹⁶

Most glaucoma patients are old aged¹⁷ which are inevitably more vulnerable to COVID-19. 19.5% of participants in our questionnaire highlighted COVID-19 amid other illnesses as an obstacle against glaucoma medication compliance. Lockdown with subsequent lack of transportation (18%) and forgetfulness (7%) were critical obstacles against compliance.

Our results are in line with several recently published studies. For instance, Subathra GN et al¹³ carried out a study to evaluate the impact of COVID-19 on patients

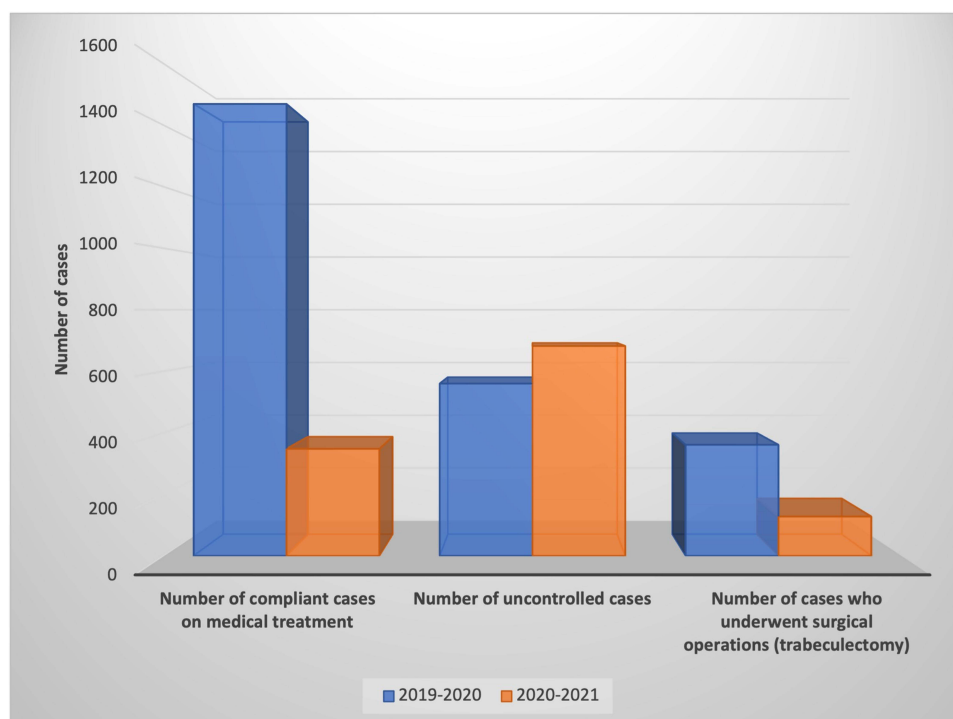


Figure 2 Number of compliant cases on medical treatment, uncontrolled cases, and cases who underwent surgical operations (trabeculectomy).

with glaucoma in a tertiary eye care center in South India. They found lockdown restrictions, transport problems, and financial difficulties as significant barriers to adherence to glaucoma treatment. Mylona I et al¹⁸, in their study in Greece, found lower adherence in older patients, especially those who have a lower educational level. Two other studies from the United States^{19,20} reported aging and forgetfulness as top barriers against treatment compliance.

Healthcare providers had implemented various innovative ways to cope with the so-called “invisible epidemic,” which involves the neglected chronic diseases during the COVID-19 pandemic.²¹ One of those ways is telemedicine. Telemedicine consists of a combination of both technologies and devices able to remotely gather data about patients’ health status to aid in deciding if there is a need or urgency to intervene.²² Many healthcare providers approved telemedicine to ease pressure over hospitals

Table 4 Number of Cases Who Underwent Surgical Operations (Trabeculectomy)

Incidence	Value
[2019–2020] incidence rate	0.131
95% CI	0.1179 to 0.1453
[2020–2021] incidence rate	0.081
95% CI	0.06793 to 0.09681
Incidence rate difference	0.050
95% CI	0.02883 to 0.07049
P-value	P < 0.0001
Incidence rate ratio	1.610
95% CI	1.3124 to 1.9852

Table 5 Number of Uncontrolled Cases

Incidence	Value
[2019–2020] incidence rate	0.203
95% CI	0.1868 to 0.2209
[2020–2021] incidence rate	0.434
95% CI	0.4019 to 0.4677
Incidence rate difference	–0.231
95% CI	–0.2637 to –0.1973
P-value	P < 0.0001
Incidence rate ratio	0.469
95% CI	0.4184 to 0.5249

Table 6 Causes of Non-Compliance

Causes of Non-Compliance N = 200	No.	%
Financial causes	43	21.5%
Other illnesses (including COVID-19)	39	19.5%
Lockdown	36	18.0%
Family member illness	26	13.0%
Not identified	18	9.0%
Medication not available	14	7.0%
Forgetfulness	14	7.0%
Did not feel improvement on drugs	6	3.0%
Drug side effects	4	2.0%

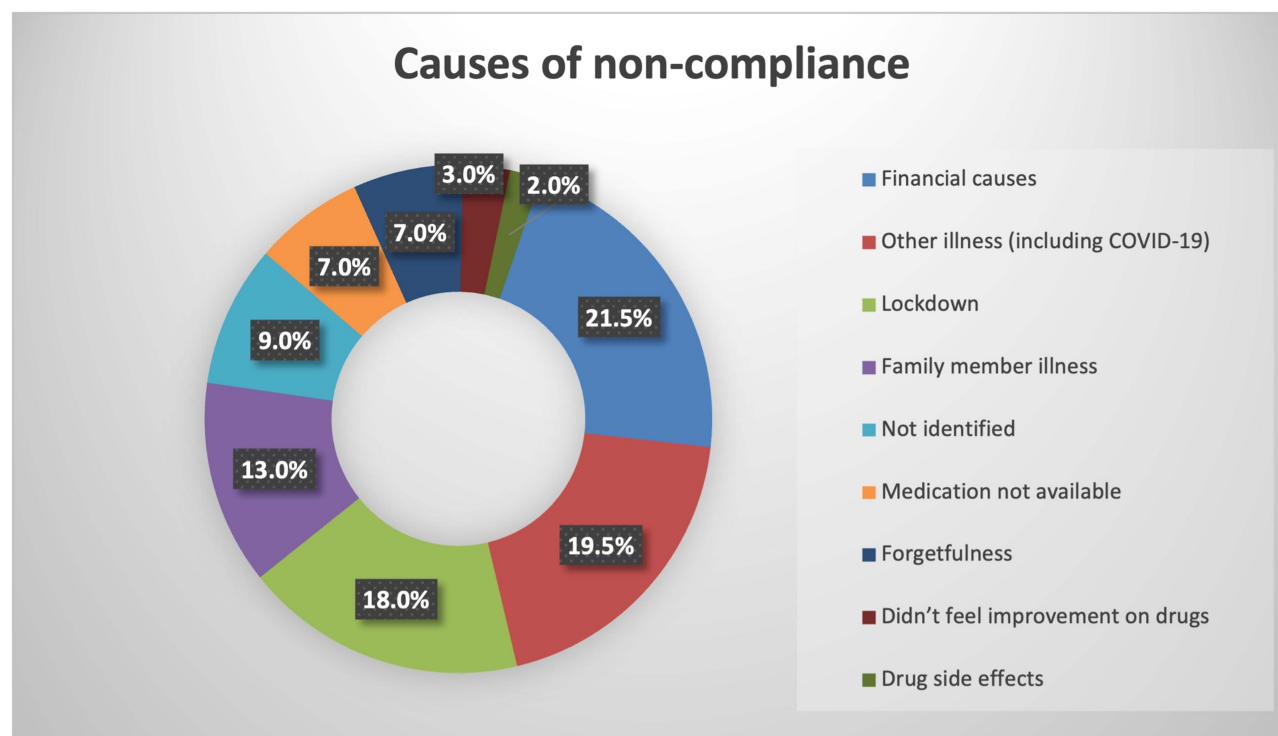
and provide patients with the necessary care without exposing them to the risk of COVID-19 infection.²³

Unfortunately, we lack the essential infrastructure and clear laws regulating the application of telemedicine in the Nile Delta region.¹⁵ It is vital to train orthoptists in the

rural and the suburban areas to regularly check patients' I. O.P., do visual fields and fundus photography and send them to the responsible ophthalmologists in the tertiary care hospitals. Well-equipped mobile units could be used to reach remote areas and have glaucoma patients checked. Media campaigns could also be helpful to increase patients' awareness and guide them to the proper way to have their eyes examined. That would greatly help to detect any deterioration in glaucoma patients' status early. Further future large-scale research is needed to determine the effects of the COVID-19 pandemic on glaucoma patients and how healthcare organizations must modify their policies to accommodate this ongoing pandemic.

Conclusion

COVID-19 had greatly hampered glaucoma care in the Nile Delta region. As a result, we need to implement new technologies like telemedicine and improve patients' awareness of glaucoma care. Training orthoptists and using mobile glaucoma care services would also be helpful ways of managing glaucoma during that pandemic.

**Figure 3** Causes of non-compliance.

Strengths and Limitations of This Study

- To the best of our knowledge, this is the first study to measure the impact of the COVID-19 pandemic over glaucoma patients in the Nile Delta region, Egypt.
- The relatively small sample size used in the questionnaire is one of the main study limitations.
- The cross-sectional nature is another limitation.

Article Summary

Primary Outcome Measures

We planned to assess the impact of the COVID-19 pandemic on glaucoma patients in the Nile Delta region, Egypt, via assessment of patients' records in the B.G. U. and establishment of a telephone-based questionnaire to clarify the causes of non-compliance.

Secondary Outcome Measures

The COVID-19 pandemic had troubled the glaucoma patients' compliance, follow-up, and overall prognosis. We could clarify the leading causes of non-compliance through the questionnaire we discussed with glaucoma patients over the phone.

Data Sharing Statement

The datasets generated and analyzed during the current study are available from this link <https://doi.org/10.5061/dryad.47d7wm3dt>.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This research received no specific grant from any funding agency in public, commercial or not-for-profit sectors.

Disclosure

The authors declare no competing interests concerning this work.

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