

Effects of COVID-19 protective measures on the ophthalmological patient examination with an emphasis on gender-specific differences

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ABSTRACT

Objective In response to the COVID-19 pandemic, strict hygiene and containment measures have been instituted in the clinical ophthalmological examination to prevent virus transmission. The aim of this study is to assess the effects of these protective measures on the quality of the examination with an emphasis on gender-specific differences.

Methods and analysis An online survey was sent to ophthalmologists in 10 countries. The collected data included demographics, place of work, current professional status, COVID-19 protective measures and their impact on the quality of the examination. Descriptive statistics were used to analyse the data. Fisher's exact test was used to analyse gender differences.

Results A total of 120 responses were collected. 54.0% of the respondents identified as female and 43.4% as male. Over 75% agreed that protective measures made the examination conditions more difficult. The major problems were fogging of the lenses (87.6%) or slit lamp oculars (69.9%), reduced operability of the slit lamp due to protective barriers (60.2%) and time delay due to disinfection measures (68.1%). Significantly more women than men reported that they used filtering face piece (FFP2) instead of surgical masks ($p=0.02$). More male participants reported that they removed their mask to prevent fogging ($p=0.01$). 31% of all participants felt that the COVID-19 protective measures reduced the overall quality of slit lamp examination and 43.4% reported a reduced quality of fundoscopic examination.

Conclusion COVID-19 related safety measures reduce the feasibility of the clinical ophthalmological examination. Practicable solutions are required to maintain good examination quality without compromising personal safety.

INTRODUCTION

A new strain of coronavirus causing respiratory diseases emerged in December 2019 in Wuhan, China.¹ In February 2020, the Coronavirus Study Group of the International Committee on Taxonomy of Viruses labelled the virus strain SARS-CoV-2 (*Severe acute respiratory syndrome-related coronavirus 2*) and the caused infection COVID-19 (*coronavirus disease 2019*).² At present, COVID-19 poses a

Key message

- ▶ Ophthalmologists are at high-risk of getting infected with COVID-19 due to the close proximity with the patient during examinations, direct contact with patients' conjunctival mucosal surfaces and high-volume and equipment-intense clinics.
- ▶ Strict hygiene and containment measures have been instituted to slow down virus transmission.
- ▶ More than 75% of ophthalmologists agreed that the COVID-19 related safety measures made the examination conditions more difficult.
- ▶ Major problems concern fogging of the lenses/slit lamp oculars, reduced operability of the slit lamp due to protective barriers and time delay due to disinfection measures.
- ▶ Male ophthalmologist in particular should be careful not to jeopardise their safety for better visualisation.

huge threat to the whole world. On 12 March 2020, the WHO declared the COVID-19 outbreak pandemic.³

SARS-CoV-2 is highly infectious. Transmission can occur through close contact with infected people through infected secretions such as saliva and respiratory secretions or their respiratory droplets, which are expelled when an infected person talks, coughs, sneezes or sings.⁴

Ophthalmologists are at high-risk of getting infected due to the close proximity with the patients during examination (close contact defined as <2m, 30min), direct contact with patients' conjunctival mucosal surfaces and high-volume and equipment-intense clinics.^{5 6} The most likely route of transmission is via aerosol spread during the eye examination.⁷ Therefore, strong hygiene and containment measures have been instituted in ophthalmology departments to slow down virus transmission.⁸ Since surgical masks dramatically reduce transmission of the virus, the American Academy of Ophthalmology



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recommends that every patient should wear a surgical mask for any ophthalmic procedure in order to prevent asymptomatic transmissions.⁹ Furthermore, the use of surgical masks or filtering face pieces (FFP) and eye protection for the ophthalmologist as well as slit lamp barriers is encouraged.¹⁰ To the best of our knowledge, little is known on the impact of these protective measures on the feasibility and quality of the clinical ophthalmological examination.

Against this background, we created an online survey addressed to ophthalmologists with the aim to assess the changes they have experienced in the ophthalmological examination due to COVID-19 protective measures.

MATERIAL AND METHODS

An anonymous web survey was created on soSci Survey (V.3.2.12) and distributed by email to ophthalmologists over a period of 8 weeks, from 1 December 2020 to 25 January 2021. The survey followed the principles of the Declaration of Helsinki, and the information on data protection was authorised by the data protection officer of the Medical University Innsbruck. Only the answers of participants who consented to the use of the data contained in the survey for scientific and statistical purposes were included in the data analysis.

The collected data included demographics (age and gender), place of work (state and type of institution), current professional status (consultant, specialist/fellow, trainee/registerar), the protective measures that have been taken to reduce the transmission of SARS-CoV-2 and the impact of these measures on the quality of the ophthalmological examination. Finally, the survey inquired whether the participants had already suffered from a COVID-19 infection. Categorical variables were summarised by percentages. Gender differences were analysed with Fisher's exact test. All statistical analysis were performed with IBM SPSS Statistics V.25.

RESULTS

Demographics and background

A total of 120 responses were collected from 10 different countries. Seven respondents did not consent to the use of data and were excluded from the data analysis.

Of the remaining 113 respondents, 61 (54.0%) identified as female and 49 (43.4%) as male. Three respondents (2.6%) did not state their gender. The participants were evenly distributed across the three age groups: 36 (31.9%) participants were between 20 and 35 years old, 31 (27.4%) were between 35 and 50 years old and 43 (38.1%) were older than 50 years old. Three (2.6%) did not choose an age category. Thirty participants (26.6%) were registrars, 44 (38.9%) were specialist or fellows and 33 (29.2%) were consultants. Six participants (5.3%) did not answer the question regarding their position. Most of the participants worked in a public hospital or clinic (66/113; 58.4%) or in a specialist practice (45/113; 39.8%) and some (10/113; 8.9%) indicated working in a private clinic (multiple responses were possible).

Measures to prevent aerosol transmission

Table 1 summarises the protective measures that have been taken to reduce the transmission of SARS-CoV-2 and their impact on the ophthalmological examination. The most common measure taken was the use of protective masks. Over 90% reported that face masks were provided for patients (94.7%) and for doctors (92.0%). The most frequent protective masks for doctors were FFP2 (69.0%). The second most common safety precaution was the use of slit lamp barriers or breath shields (92.9%).

In total, over 75% agreed that the protective measures made the examination conditions more difficult or changed them. Most of the participants reported that the fogging of the lenses presented a major problem (87.6%), and a majority stated the fogging of the slit lamp oculars (69.9%) and difficulties operating the slit lamp due to the slit lamp protective barriers (60.2%) as a challenge. Communication problems and headaches due to the mask as well as fogging of the glasses of the examiner were mentioned as well.

To avoid fogging of the oculars or lenses, the majority of participants reported that they repeatedly interrupted the examination (67.7%) or tried to improve the fitting of the face masks by pressing the patient's mask with the fingers to the patient's face (47.5%) or taping the upper edge of the patient's mask to the face (20.2%) or their own mask to their face (31.6%). Only 5.1% of the respondents removed the face mask completely, but a high percentage pulled the patient's mask (45.5%) or their own mask (26.6%) under the nose to improve the quality of the examination. A small percentage of respondents tried to replace funduscopy with fundus photography (11.1%) or avoided funduscopy (5.1%).

Almost one-third of the respondents felt that the COVID-19 protective measures reduced the overall quality of their slit lamp examination (31.0%) and even more felt that the quality of their fundoscopic examination was reduced (43.4%).

Measures to prevent smear infections

A large proportion of participants reported that the time delay caused by disinfection measures (68.1%) had an impact on their daily routine. Many of the participating ophthalmologists disinfected their hands and the examination unit after every examination and >75% disinfected their lenses at least once a day. Table 2 shows the disinfection measurements due to COVID-19 in detail.

COVID-19 infections

Only one-fourth of the participants were afraid to become infected with SARS-CoV-2 during the ophthalmological examination, and more than half of the ophthalmologist felt adequately protected by the protective measures taken, even though almost 40% examined SARS-CoV-2 positive patients. In total 15/113 respondents had been tested positive for SARS-CoV-2 (13.3%). Just one infection could be traced to a contact with an infected patient. The COVID-19 infections are summarised in table 3.

Table 1 Protective measures taken to reduce the transmission of SARS-CoV-2 and the impact on the ophthalmological examination

Question	Women		Men		All	
	n	(%)	n	(%)	n	(%)
What protective measures have been taken to reduce the transmission of SARS-CoV-2 at your work place?						
Face masks for patients	60	(98.4)	47	(95.9)	107	(94.7)
Face masks for doctors	58	(95.1)	46	(93.9)	104	(92.0)
Barrier measures on the slit lamp	60	(98.4)	45	(91.8)	105	(92.9)
Wearing protective gloves	26	(42.6)	13	(26.5)	39	(34.5)
Surface disinfection after using the slit lamp	56	(91.8)	41	(83.7)	97	(85.8)
Fever measurement and symptom questionnaire before the examination	29	(47.5)	23	(46.9)	52	(46.0)
Reduction of the planned appointments	36	(59.0)	27	(55.1)	63	(55.8)
Others	13	(21.3)	7	(14.3)	20	(17.7)
Which face mask do you use most frequently?						
Cloth mask	1	(1.6)	0	(0.0)	1	(0.9)
Surgical mask	4	(6.6)	11	(22.4)	15	(13.3)
FFP1 mask	1	(1.6)	3	(6.1)	4	(3.5)
FFP2 mask	49	(80.3)	29	(59.2)	78	(69.0)
FFP3 mask	1	(1.6)	0	(0.0)	1	(0.9)
Faceshield	1	(1.6)	0	(0.0)	1	(0.9)
Who provided the masks?						
Employer	37	(60.7)	25	(51.0)	62	(54.9)
Representation of interests, for example, medical association	9	(14.8)	11	(22.4)	20	(17.7)
Financed from own resources	11	(18.0)	7	(14.3)	18	(15.9)
In your experience, have these protective measures made the examination conditions more difficult/changed them?						
Totally agree	25	(41.0)	29	(59.2)	54	(47.8)
Rather agree	21	(34.4)	15	(30.6)	36	(31.9)
Neither agree nor disagree	13	(21.3)	4	(8.2)	17	(15.0)
Rather disagree	1	(1.6)	0	(0.0)	1	(0.9)
Disagree	1	(1.6)	0	(0.0)	1	(0.9)
Not answered	0	(0.0)	1	(2.0)	4	(3.5)
Which difficulties do you experience due to the protective measures?						
Fogging of the slit lamp oculars	40	(65.6)	39	(79.6)	79	(69.9)
Fogging of the lenses	55	(90.2)	44	(89.8)	99	(87.6)
Difficult operability of the slit lamp due to the slit lamp protection barriers	42	(68.9)	26	(53.1)	68	(60.2)
Time delay due to disinfection measures	43	(70.5)	34	(69.4)	77	(68.1)
Others	8	(13.1)	3	(6.1)	11	(9.7)
What do you do to stop fogging of the oculars?						
You completely remove your face mask	1	(2.5) [†]	3	(7.7) [†]	4	(5.1) [†]
You pull your face mask under the nose	7	(17.5) [†]	14	(35.9) [†]	21	(26.6) [†]
You hold your breath during examination	22	(55.0) [†]	21	(53.8) [†]	43	(54.4) [†]
You tape off the upper edge of the face mask to your skin	10	(25.0) [†]	15	(38.5) [†]	25	(31.6) [†]
Others	7	(17.5) [†]	3	(7.7) [†]	10	(12.7) [†]
What do you do to stop lens fogging?						

Continued

Table 1 Continued

Question	Women		Men		All	
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
You ask the patient to completely remove their face mask	3	(5.5)*	2	(4.5)*	5	(5.1)*
You ask the patient to pull the face mask under the nose	26	(47.3)*	19	(43.2)*	45	(45.5)*
You press the face mask with your fingers to the patient's face to minimise the escaping air	28	(50.9)*	19	(43.2)*	47	(47.5)*
You tape the upper edge of the patient's mask to their face	12	(21.8)*	8	(18.2)*	20	(20.2)*
You interrupt the examination several times	39	(70.9)*	28	(63.6)*	67	(67.7)*
You are trying to avoid funduscopy	2	(3.6)*	3	(6.8)*	5	(5.1)*
You are trying to replace funduscopy with fundus photography	6	(10.9)*	5	(11.4)*	11	(11.1)*
Others	4	(7.3)*	6	(13.6)*	10	(10.1)*
How many patients do you examine per day on average?						
0–10	7	(11.5)	3	(6.1)	7	(6.2)
10–20	38	(62.3)	14	(28.6)	38	(33.6)
20–30	31	(50.8)	13	(26.5)	31	(27.4)
30–40	12	(19.7)	8	(16.3)	12	(10.6)
>40	21	(34.4)	10	(20.4)	21	(18.6)
Not answered	4	(6.6)	1	(2.0)	4	(3.5)
How many patients per day on average do you perform funduscopy on?						
0–10	15	(24.6)	10	(20.4)	25	(22.1)
10–20	21	(34.4)	20	(40.8)	41	(36.3)
20–30	15	(24.6)	5	(10.2)	20	(17.7)
30–40	4	(6.6)	7	(14.3)	11	(9.7)
>40	6	(9.8)	6	(12.2)	12	(10.6)
Not answered	0	(0.0)	1	(2.0)	4	(3.5)
In your experience, have COVID-19 protective measures reduced the overall quality of your fundoscopic examination?						
Totally agree	7	(11.5)	11	(22.4)	18	(15.9)
Rather agree	19	(31.1)	12	(24.5)	31	(27.4)
Neither agree nor disagree	14	(23.0)	9	(18.4)	23	(20.4)
Rather disagree	7	(11.5)	6	(12.2)	13	(11.5)
Disagree	13	(21.3)	10	(20.4)	23	(20.4)
Not answered	1	(1.6)	1	(2.0)	5	(4.4)
In your experience, have COVID-19 protective measures reduced the overall quality of your slit lamp examination?						
Totally agree	5	(8.2)	6	(12.2)	11	(9.7)
Rather agree	10	(16.4)	14	(28.6)	24	(21.2)
Neither agree nor disagree	19	(31.1)	7	(14.3)	26	(23.0)
Rather disagree	12	(19.7)	8	(16.3)	20	(17.7)
Disagree	15	(24.6)	13	(26.5)	28	(24.8)
Not answered	0	(0.0)	1	(2.0)	4	(3.5)

*Percentage of persons that selected 'Fogging of the lenses'.

†Percentage of persons that selected 'Fogging of the slit lamp oculars'.

FFP, filtering face piece.

Table 2 Disinfection measurements due to COVID-19

Question	Women		Men		All	
	n	(%)	n	(%)	n	(%)
How often do you disinfect your hands?						
Always (after every examination)	48	(78.7)	31	(63.3)	79	(69.9)
Often	12	(19.7)	15	(30.6)	27	(23.9)
Rarely	0	(0.0)	2	(4.1)	2	(1.8)
Never	1	(1.6)	0	(0.0)	1	(0.9)
Not answered	0	(0.0)	1	(2.0)	4	(3.5)
Do you lift the patient's upper eyelid for the funduscopy while they are looking down?						
Always (in every examination)	33	(54.1)	21	(42.9)	54	(47.8)
Often	26	(42.6)	26	(53.1)	52	(46.0)
Rarely	2	(3.3)	0	(0.0)	2	(1.8)
Never	0	(0.0)	1	(2.0)	1	(0.9)
Not answered	0	(0.0)	1	(2.0)	4	(3.5)
How often do you or your assistant take the time to disinfect the examination unit after the examination?						
Always (after every examination)	39	(63.9)	27	(55.1)	66	(58.4)
Often	19	(31.1)	16	(32.7)	35	(31.0)
Rarely	2	(3.3)	5	(10.2)	7	(6.2)
Never	1	(1.6)	0	(0.0)	1	(0.9)
Not answered	0	(0.0)	1	(2.0)	4	(3.5)
What are you disinfecting?						
Chin and forehead rest of the patient	60	(98.4)	48	(98.0)	108	(95.6)
Slit lamp handles	41	(67.2)	32	(65.3)	73	(64.6)
Examination chair	38	(62.3)	32	(65.3)	70	(61.9)
How often do you disinfect your lenses?						
After each examination	13	(21.3)	11	(22.4)	24	(21.2)
Several times a day	26	(42.6)	13	(26.5)	39	(34.5)
Every day	12	(19.7)	13	(26.5)	25	(22.1)
Once a week	1	(1.6)	5	(10.2)	6	(5.3)
Less than once a week	8	(13.1)	5	(10.2)	13	(11.5)
Never	1	(1.6)	1	(2.0)	2	(1.8)
Not answered	0	(0.0)	1	(2.0)	4	(3.5)

Gender aspects

When comparing the answers given by female and male respondents, we found no significant difference in 95% of the answers. A significant difference between men and women was found regarding the type of protective mask worn. More women reported that they used FFP2 masks (women: 80.3% vs men: 59.3%, $p=0.02$), and more men reported that they used surgical masks (women: 6.6% vs men: 22.4%, $p=0.02$). Furthermore, there was a significant difference in dealing with the fogging of the slit lamp oculars. In total, 43.6% of men tried to improve the examination conditions by removing their face mask or pulling it under their nose, whereas women did so less frequently (20.0%, $p=0.01$).

DISCUSSION

This survey highlights the impact of protective measures due to the COVID-19 pandemic on the clinical ophthalmological examination. More than 75% of participants agreed that the protective measures taken made the ophthalmological examination conditions more difficult or changed them.

The necessity and effectiveness of slit lamp barriers in combination with face masks have been shown in several studies so far.^{11–13} However, these measures lead to major practical problems in the ophthalmological examination. Fogging occurs during slit lamp examination on both doctor's and patient's side as the face masks direct much of the exhaled air upwards, where it gets into contact with the lenses (spectacles, slit lamp oculars and funduscopy

Table 3 COVID-19 infections

Question	Women		Men		All	
	n (%)		n (%)		n (%)	
Are you afraid to become infected with SARS-CoV-2 during the ophthalmological examination?						
Totally agree	7	(11.5)	4	(8.2)	11	(9.7)
Rather agree	10	(16.4)	9	(18.4)	19	(16.8)
Neither agree nor disagree	14	(23.0)	7	(14.3)	21	(18.6)
Rather disagree	19	(31.1)	20	(40.8)	39	(34.5)
Disagree	11	(18.0)	8	(16.3)	19	(16.8)
Not answered	0	(0.0)	1	(2.0)	4	(3.5)
Have you already examined SARS-CoV-2 positive patients?						
Yes	28	(45.9)	17	(34.7)	45	(39.8)
No, not knowingly	33	(54.1)	30	(61.2)	63	(55.8)
Not answered	0	(0.0)	2	(4.1)	5	(4.4)
Did you know that the patient was SARS-CoV-2 positive at the time of the examination?						
Yes, the patient was SARS-CoV-2 positive and had COVID-19 symptoms	13	(46.4)*	5	(29.4)*	18	(40.0)*
Yes, the patient was SARS-CoV-2 positive but asymptomatic	13	(46.4)*	9	(52.9)*	22	(48.9)*
No, the result of the test for SARS-CoV-2 was still pending	7	(25.0)*	3	(17.6)*	10	(22.2)*
No, the patient was only tested positive for SARS-CoV-2 after the examination	15	(53.6)*	2	(11.8)*	17	(37.8)*
How many SARS-CoV-2 positive patients have you already examined?						
1–3	13		12		25	
3–5	10		3		13	
5–10	3		1		4	
>10	2		1		3	
You have the feeling that you are adequately protected by the protective measures taken						
Totally agree	14	(23.0)	10	(20.4)	24	(21.2)
Rather agree	26	(42.6)	23	(46.9)	49	(43.4)
Neither agree nor disagree	15	(24.6)	12	(24.5)	27	(23.9)
Rather disagree	6	(9.8)	2	(4.1)	8	(7.1)
Disagree	0	(0.0)	1	(2.0)	1	(0.9)
Not answered	0	(0.0)	1	(2.0)	4	(3.5)
Have you been tested positive for SARS-CoV-2 so far?						
Yes	6	(9.8)	9	(18.4)	15	(13.3)
No	55	(90.2)	39	(79.6)	94	(83.2)
Not answered	0	(0.0)	1	(2.0)	4	(3.5)
Did you have typical COVID-19 symptoms (fever, cough, taste and smell disorders, tiredness/fatigue and aching)						
Yes	1	(16.7)*	3	(33.3)*	4	(26.7)*
No	5	(83.3)*	7	(77.8)*	12	(80.0)*
Not answered	1	(16.7)*	0	(0.0)*	1	(6.7)*
Can your infection be traced to a contact with an infected patient?						
Yes	0	(0.0)*	1	(11.1)*	1	(6.7)*
No	3	(50.0)*	3	(33.3)*	6	(40.0)*
Uncertain	0	(0.0)*	4	(44.4)*	4	(26.7)*
Not answered	4	(66.7)*	2	(22.2)*	6	(40.0)*

*Percentage of persons that have been tested positive for SARS-CoV-2.

lenses).¹⁴ In contrast to other specialities examining the patient's face, such as otorhinolaryngology, dentistry or maxillofacial surgery, masks can be kept on during the ophthalmological examination to protect the examiner and the patient. 87.6% of the participants reported fogging of the lenses, 69.9% fogging of the slit lamp oculars and 60.2% reported difficulties when operating the slit lamp due to the slit lamp protective barriers. In order to improve examination conditions, doctors are forced to change their examination methods (67.7% interrupted the examination several times, 47.5% pressed the patient's mask with the fingers to the patient's face during the examination) or they risked their own health to improve visualization. Interestingly, significantly more men are willing to reduce their own protection for better examination conditions. In total, 43.6% of male participants removed their face mask or pulled it under their nose to prevent the tarnishing of the slit lamp oculars, but only 20% of female respondents did so. Additionally, in our study, significantly more men wore surgical masks instead of FFP2 masks (international equivalent standards are KN95 and N95), although the protection factor of FFP respirators are 12 to 16 times greater than those of surgical masks.¹⁵ These results coincide with the findings that men are typically more likely to engage in risky behavior.¹⁶

There are some alternative approaches to prevent tarnishing of the lenses that do not compromise personal safety: taping the upper margin of the face mask to prevent the air draft, using antifog or soap agents that leave behind a thin surfactant film that reduces surface tension or keeping the funduscopy lens in a warm water bowl at 40°C after disinfection with 70% ethanol. This method reduces the temperature difference and prevents fogging while ensuring decontamination.¹⁴ In our survey, it was notable that more men than women taped the upper edge of the face mask to their skin (women: 25.0% vs men: 38.5%), even though the gender difference was not significant. Furthermore, a particularly large number of women found it difficult to operate the slit lamp with the slit lamp barrier. This could be due to sex-typical physiognomic characteristics as women have a shorter arm span on average.^{17 18}

Fortunately, only 1/15 SARS-CoV-2 infections could be traced to a contact with an infected patient, but in this case a male ophthalmologist was affected. However, as the mean incubation period of COVID-19 is 6.2 days and incubation periods go up to 14 days, contact tracing is not always possible and the exact number of transmissions from patient to physician cannot be verified.¹⁹

As almost one-third of the respondents felt that the COVID-19 protective measures reduced the overall quality of their slit lamp examination (31.0%) and even more felt that the quality of their fundoscopic examination was reduced (43.4%), there is a chance that pathologies might be overlooked. Even though artificial intelligence has been applied to fundus photographs, optical coherence tomography and visual fields and is achieving robust

classification performance in the detection of diabetic retinopathy, age-related macular degeneration and glaucoma, it has not yet found its way into daily practice.²⁰ Just 11.1% of participants tried to replace funduscopy with fundus photography. The examination by an ophthalmologist is irreplaceable for detecting pathologies in the retinal periphery, such as retinal tears. Furthermore, machine learning programmes are often not able to include the ambiguity and variability that is intrinsic to the nature of clinical observations.²¹

A limitation of this study is that self-reported surveys have well-known drawbacks. Moreover, due to the rapidly changing COVID-19 situation, the survey questions are not standardised, and it was not possible to conduct a validated survey.

CONCLUSION

In conclusion, the feasibility of the clinical ophthalmological examination is reduced due to COVID-19 related safety measures. Practicable solutions are required to maintain good examination quality without compromising personal safety and to ensure that protection is always maintained. Male ophthalmologist in particular should be careful not to jeopardise their safety for better visualisation.

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Data availability statement Data are available on reasonable request. The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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