The Impact of Tape Sealing Face Masks on Visual Field Scores in the Era of COVID-19: A Randomized Cross-over Study

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Precis: Tape sealing of the face mask can prevent fogging artifacts of visual field testing. Here, we demonstrate that tape sealing can improve visual field scores even when fogging artifacts are not obvious.

Purpose: The purpose of this study was to demonstrate that visual field scores improve when the face masks are taped to prevent fogging artifacts.

Methods: A Single-center, randomized 2×2 cross-over study. Twenty-six visual fields of 13 patients of the glaucoma outpatient clinic were included. Patients were randomized in either sequence 1 (Octopus visual field examination without tape sealing, followed by examination with tape sealing) or sequence 2 (examination with, followed by without tape sealing).

Results: The results for mean defect and square root of loss variance differ significantly in the examination with and without tape sealing [mean difference (without−with) 0.39 dB, 95% confidence interval: 0.07-0.70 dB, $P=0.018$ and 0.49 dB, 95% confidence interval: 0.19-0.79 dB, $P=0.003$, respectively]. There was no sequence effect ($P=0.967$) for mean defect nor the square root of loss variance ($P=0.779$). A significant effect for period ($P=0.023$) for mean defect was yielded.

Conclusion: Tape sealing of face masks during visual field testing prevented fogging artifacts and improved visual field scores even when fogging artifacts were not obvious and should be considered in clinical practice.

Key Words: COVID-19, face mask, glaucoma, octopus, visual field

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To contain the coronavirus disease 2019 (COVID-19), pandemic face masks, and social distancing became part of our daily routine in health care. Consequently, we had to rethink and adapt our clinical work.[1] Several hygiene and disinfection measures, especially in outpatient glaucoma care had to be implemented.[2] The American Academy of Ophthalmology recommends masks or face covering on patients at all times.[3] As the perimetry bowl is a potential source of viral spread,[4] face masks have to be worn also during visual field testing.

Glaucoma progression is associated with the development and progression of visual field defects, and thus regular perimetry is mandatory. When interpreting visual fields several aspects have to be considered. First, many patients do not perform well at their initial visual field assessment and improve on consecutive examinations.[5,6] Therefore, visual field defects have to be confirmed in follow-up tests to avoid false-positive diagnoses.[7] Second, visual fields can deteriorate due to reasons other than a glaucomatous progression, like fatigue effects,[8] lens rim artifacts,[9] blepharochalasis,[10] or dry eye.[11]

Fogging of glasses is an issue with face mask use, and several methods have been described to avoid it including adhesive bands,[12] the use of 2 masks[13] or special mask tying techniques.[14] During visual fields refractive lenses are used and several studies highlight the issue of fogging artifacts when face masks are worn during visual field testing.[15–17] It remains to be clarified whether taping should be done on a regular basis or only after fogging artifacts are identified. The aim of this study is to provide evidence that visual field scores are improved with face masks taped even if no obvious artifacts are present.

METHODS

This cross-over, single-center study was conducted at the Department of Ophthalmology, Medical University Graz, Austria in accordance with the tenets of the Declaration of Helsinki. Institutional Review Board/Ethics Committee approval was obtained, and written informed consent was obtained from all participants. The patients underwent visual field assessment of both eyes (always starting with the right one) with Octopus 900 (Haag Streit, Switzerland) G2 program (glaucoma perimetry, white-on-white) between August 2020 and October 2020.

Patients routinely scheduled for visual field testing were included. Exclusion criteria were visual acuity <1.0 logMAR (logarithm of the minimum angle of resolution) and inability to conduct visual field testing due to patients´ cognitive decline. The enrolled patients were already experienced in visual field testing and had a minimum of 3 prior visual fields. All patients were wearing surgical face masks with earloops. The face masks were sealed with an adhesive band beginning from 1 cheek bone via the bridge of the nose to the other cheek bone. Patients were randomized by a computer-based system (www.randomizer.org) into the following sequences: sequence 1 (visual field examination without tape sealing followed by visual field examination with tape sealing) and sequence 2 (visual field examination with, followed by without tape

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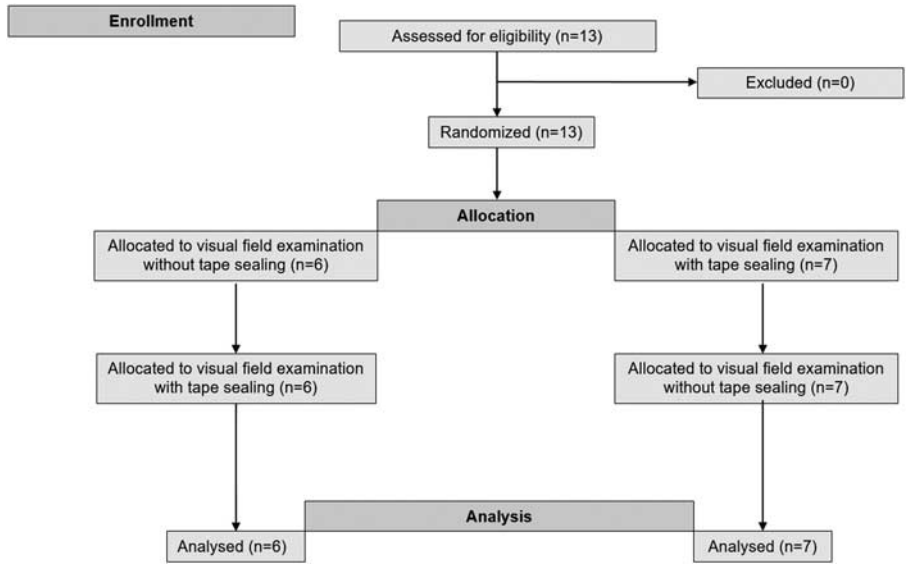

FIGURE 1. Overview of the participant's flow through the study. Eligible patients were randomized to sequence 1 (visual field examination without tape sealing followed by visual field examination with tape sealing) or sequence 2 (visual field examination with, followed by without tape sealing the face mask).

sealing the face mask) (Fig. 1). The second examination took place immediately after the first one. Visual field outcomes were described by using mean defect (MD) and the square root of loss variance (sLV).

Patients were enrolled on routine follow-up visits. We included all ocular examinations in our study to give a comprehensive picture of our participants. Ocular examination including best-corrected visual acuity, Goldmann applanation tonometry and slit-lamp biomicroscopy, as well as optical coherence tomography (OCT) (Spectralis; Heidelberg Engineering, Germany) of the optic disc were performed. Glaucoma suspects had optic discs that appeared indicative for glaucoma but did not have nerve fiber layer thinning on OCT, visual field defects, or intraocular pressure (IOP) > 21 mm Hg. Primary open-angle glaucoma (POAG) was diagnosed after detection of retinal nerve fiber layer thinning beyond normal values of the age-adjusted normative database on OCT, corresponding visual field defects, and untreated IOP > 1 mm Hg. Eight participants were glaucoma suspects, 3 had ocular hypertension (OHT), and 2 had mild POAG. Patients with OHT and POAG were treated with prostaglandin analogs. No patients with normal-tension glaucoma have been included. Patients with OHT had IOP > 21 mm Hg but did not have any structural or functional damage indicative for glaucomatous optic neuropathy. None of the patients had relevant blepharochalasis or clinical signs or symptoms indicative of dry eye disease.

Statistical Analysis

The 2×2 cross-over study was analyzed using a linear mixed model with fixed-effects for treatment/examination (visual field testing with or without tape sealing), periods (1, 2), and sequence of the examinations (sequence 1: without−with and sequence 2: with−without tape sealing) and random effects for subject and eye nested within subject. The differences

TABLE 1. Clinical Data

	Total	Sequence 1	Sequence 2
Sex [n (%)]			
Female	6 (46.2)	3 (50.0)	3 (42.9)
Male	7 (53.9)	3 (50.0)	4 (57.1)
Age [mean ± SD (range)] (y)	46.8 ± 13.1 (19-66)	42.7 ± 15.6 (19-66)	50.4 ± 10.4 (19-66)
Diagnosis [n (%)]			
Glaucoma suspect	8 (61.5)	4 (66.7)	4 (57.1)
Ocular hypertension	3 (23.1)	1 (16.7)	2 (28.6)
POAG	2 (15.4)	1 (16.7)	1 (14.3)
Visual acuity [mean ± SD (range)] (logMAR)	0.0 ± 0.1 (−0.1 to 0.4)	0.0 ± 0.1 (−0.1 to 0.2)	0.1 ± 0.1 (0.0-0.4)
IOP [mean ± SD (range)] (mm Hg)	18.0 ± 3.7 (14-26)	15.7 ± 1.9 (14-19)	19.9 ± 3.8 (16-26)
No. IOP-lowering medication per eye [n (%)]			
0	21 (80.8)	7 (58.3)	14 (100)
1	5 (19.2)	5 (41.7)	0 (0)
Global RNFL thickness [mean ± SD (range)] (μm)	101.2 ± 13.4 (69-122)	102.7 ± 15.4 (69-122)	99.9 ± 11.9 (79-122)

Sequence 1: visual field examination without tape sealing followed by visual field examination with tape sealing.
Sequence 2: Visual field examination with, followed by without tape sealing the face mask.
IOP indicates intraocular pressure; logMAR, logarithm of the minimum angle of resolution; POAG, primary open-angle glaucoma; RNFL, retinal nerve fiber layer.

TABLE 2. Descriptive Results for Outcome Measures by Examinations (Visual Field Testing With/Without Tape Sealing the Face Mask) and Period

	Without Tape Sealing			With Tape Sealing		
	N	Mean	SD	N	Mean	SD
Period 1						
MD (dB)	12	2.50	2.66	14	2.16	2.17
sLV (dB)	12	3.44	1.51	14	3.15	1.26
Period 2						
MD (dB)	14	2.92	2.92	12	2.48	2.44
sLV (dB)	14	3.82	3.82	12	3.14	1.52
Pooled						
MD (dB)	26	2.73	2.73	26	2.31	2.26
sLV (dB)	26	3.65	3.65	26	3.15	1.36

MD indicates mean defect; sLV, square root of loss variance.

between the 2 examinations are presented as least square means with SEs and the corresponding 95% confidence intervals (CIs). Model assumptions were checked graphically in the residual analysis of the models. A P-value of <0.05 is interpreted as statistically significant. In descriptive statistics, results are presented as mean ± SD and number (%). The data was analyzed using SAS, version 9.4 (Cary, NC).

RESULTS

Overall, 26 eyes from 13 patients of the glaucoma outpatient clinic were included, whereby 6 patients (12 eyes) were randomized in the sequence visual field examination without tape sealing followed by visual field examination with tape sealing the face mask (sequence 1). Seven patients (14 eyes) were randomized in the sequence visual field examination with, followed by without tape sealing the face mask (sequence 2).

Detailed demographic and clinical characteristics are shown in Table 1. The mean age was 46.8 ± 13.1 years at the time of examination. Diagnoses were glaucoma suspect (n = 8), OHT (n = 3), and POAG (n = 2). Mean visual acuity was 0.0 ± 0.1 (−0.1 to 0.4) logMAR, mean IOP was 18.0 ± 3.7 (14 to 26) mm Hg. One IOP-lowering medication (prostaglandin analog) was used in 5 patients. The mean global retinal nerve fiber layer thickness measured by OCT was 101.2 ± 13.4 (69 to 122) µm.

The mean duration of visual field examination per eye was 9:30 minutes in the first and 9:29 minutes in the second examination. Descriptive results for MD and sLV for the first and second visual field examination (periods 1 and 2), and both periods pooled are presented in Table 2. Linear mixed-model analysis for MD yielded no significant sequence effect ($P = 0.967$) and a significant effect for the period ($P = 0.023$). Mean MD values for both examinations with and without tape sealing were higher in the second examination compared with the first (Table 2). For sLV, no significant sequence ($P = 0.779$) and period effects ($P = 0.215$) were observed. An example of visual fields before and after tape sealing the face mask is shown (Fig. 2).

The results for the visual field examinations with and without tape sealing differ significantly for MD (mean difference without−with tape sealing: 0.39 dB, 95% CI: 0.07-0.70 dB) and sLV (mean difference without−with tape sealing: 0.49 dB, 95% CI: 0.19-0.79) as presented in Table 3.

DISCUSSION

Our study shows that tape sealing the face mask during visual field testing significantly influences the visual field scores confirmed by the difference in MD and sLV. This is of particular interest since artifacts might lead to a false interpretation of visual field defects and consequently potentially to otherwise unnecessary interventions.

The same conclusion was described in the case reports of El-Nimri et al.[16] They stated that a secure taping of the face mask may minimize the problem of fogging resulting in unreliable visual field testing and reduce additional testing and follow-up visits. In their study, all patients reported fogging by themselves, and all of them had the face mask

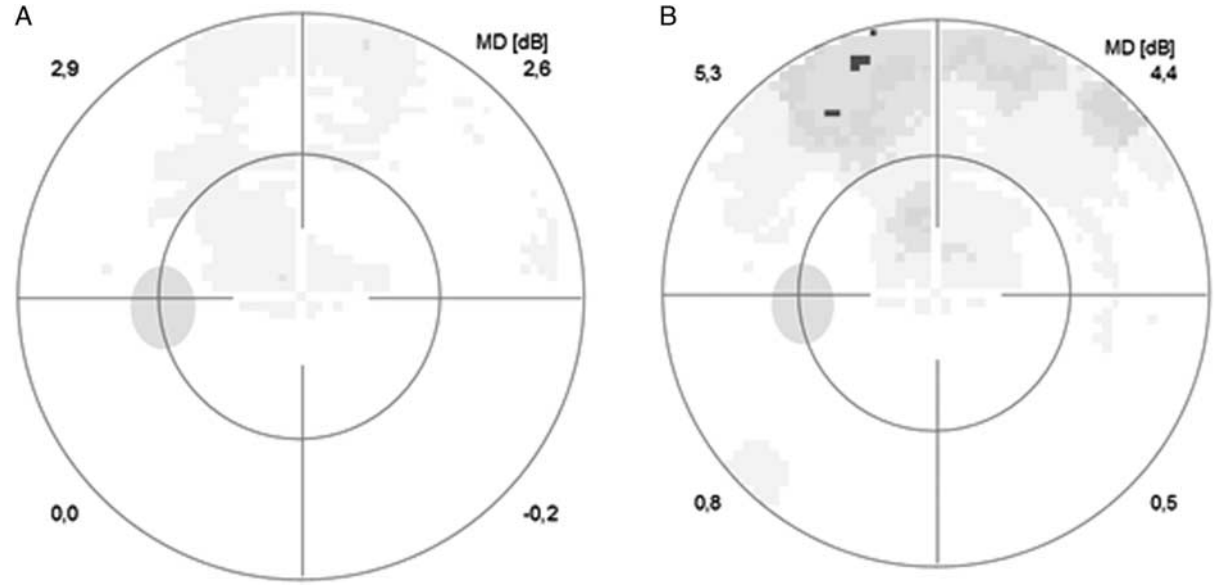

FIGURE 2. Visual fields of a glaucoma suspect with (A) and without (B) tape sealing the face mask. Mean defect (MD) and square root of loss variance for visual field with tape sealing are 1.4 and 2.3 dB (A). MD and square root of loss variance for visual field without tape sealing the face mask are 2.8 and 3.4 dB (B).

TABLE 3. Results From Mixed-model Analysis for Difference in the Visual Field Examinations With and Without Tape Sealing

	Without Tape Sealing (N = 26)	With Tape Sealing (N = 26)	Difference (Without−With Tape Sealing) (N = 26)	*P*
MD (dB)				
LS mean (SE)	2.71 (0.61)	2.32 (0.61)	0.39 (0.15)	0.018
95% CI	1.45-3.97	1.07-3.58	0.07-0.70	
sLV (dB)				
LS mean (SE)	3.63 (0.35)	3.15 (0.35)	0.49 (0.15)	0.003
95% CI	2.91-4.35	2.43-3.87	0.19-0.79	

CI indicates confidence interval; LS, least squares; MD, mean defect; sLV, square root of loss variance.

sealed on the second examination.[16] In contrast to their study, we chose a randomized cross-over design to address fatigue effects, which could have hampered the second testing. We indeed found a fatigue effect given the effect for the period ($P = 0.023$). Furthermore, our patients had only mild or no glaucomatous damage since we wanted to see whether there is an effect of tape sealing in general. As the variability of visual fields increases with reduced sensitivity,[18,19] it remains to be established whether the rather small effect of tape sealing can also be found in patients with advanced glaucoma. The artifacts found in our study were diffuse and did not resemble glaucomatous visual field defects. This was the same for glaucoma suspects, patients with OHT or POAG. As none of the patients reported fogging, the artifacts could have been misinterpreted as actual progression. This highlights the necessity of face mask sealing to have a comprehensive base for clinical decision-making. We could not detect a clear common feature of the face mask–related artifacts. There was no specific location or form. Still, in general, the artifacts were more at the periphery of the visual field than in the center, which is in line with previous observations.[15–17] Unlike previous reports, we did not find any artifacts resembling typical glaucomatous visual field defects, which may be due to a different study design and because our participants were mainly glaucoma suspects and OHT patients.

A recent study by Bayram et al[15] showed that taping face masks can significantly elevate the reliability of visual fields. The authors admit that the improvement in the second visual field could be due to learning effects. To address this issue, we chose a cross-over design in our trial.

Another case report of Young et al[17] also outlined this new cause of visual field artifacts. In their case, a marked reduction in sensitivity was found inferiorly. Repeating the examination with a properly fitting face mask (well-sealed upper border, nasal strip pinched down), they found the visual field to be normal. In our patients, no artifact due to the upper edge of the face mask was identifiable, neither before nor after tape sealing.

As a limitation of our study, the lack of a "washout phase" has to be addressed as the second examination was conducted immediately after the first one. Further, we did not examine patients with advanced glaucoma. The effect of tape sealing might be harder to detect in visual fields of patients with advanced glaucoma due to an increased inter-test variability. Our results relate to examinations with Octopus 900 G2 program. We can only suppose that the same effects would arise in visual field examinations with longer duration, but for statistical evidence, further studies have to be conducted.

Our results indicate that tape sealing the face mask during visual field examination may avoid artifacts and thus contribute to more objectivity of visual field testing in patients with glaucoma.

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