The Impacts of Face Mask Use on Standard Automated Perimetry Results in Glaucoma Patients

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Purpose: The coronavirus disease 2019 (COVID-19) spread rapidly worldwide, causing a severe outbreak. Because the disease is easily transmitted, face masks are a vital tool to slow the spread. The aim of this study is to investigate the impacts of face mask use on standard automated perimetry (SAP) results in glaucoma patients.

Materials and Methods: All follow-up glaucoma patients who underwent SAP between May and October 2020 were enrolled in this study. In patients with low test reliability and/or visual field changes, SAP was repeated after repositioning and taping patients’ face masks.

Results: A total of 127 patients (59 female and 68 male) with a mean age of 59.8 ± 10.3 years were included in the study. While 101 patients (79.5%) wore surgical face masks, 26 patients (20.5%) wore cloth face masks. Low SAP reliability appeared in 25 patients (18.1%), and inferior visual field defects were present in 3 patients (2.4%). The main effects of poorly fitting face masks on SAP reliability were increased fixation losses and false-positive errors (for both, \( P = 0.001 \)). Low SAP reliability was significantly higher in patients wearing cloth face masks than in those wearing surgical face masks (47.8% vs. 9.9%; \( P = 0.0001 \)). The face mask–related fogging of eyeglasses before SAP is a strong predictor of fogging of the trial lenses–related low SAP reliability (odds ratio: 27; 95% confidence interval: 5.48–132.92, \( P = 0.001 \)). In all repeated SAPs, the patients’ reliability parameters improved, and inferior visual field artifacts disappeared.

Conclusions: Unsuitable face masks can cause either visual field artifacts, which may be interpreted as glaucoma progression or low test reliability. Taping the face masks’ upper edges is an effective technique to prevent visual field artifacts and obtain good test reliability.

Key Words: face masks, glaucoma, standard automated perimetry, perimetric reliability parameters, visual field artifacts

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The coronavirus disease 2019 (COVID-19) is characterized by severe acute respiratory syndrome, which results in illness or death in every nation. Human to human transmission happens with close contact with infected patients. The primary way to transmit the COVID-19 is respiratory droplets that spread respiratory pathogens when an infected person coughs, sneezes, or talks. The main recommendations to reduce patient flow, physical distancing, the use of face masks by patients and staff, meticulously cleaned equipment, and wearing gloves and regular hand washing is reduced patient contact.

The COVID-19 pandemic has impacted all aspects of eye care, including glaucoma practice, in several ways, and these effects can cause unintended consequences. Due to COVID-19 protection measures, all hospital staff and patients must wear face masks during all examination procedures, including perimetry tests. Because of physical distance, visual field technicians cannot follow patients closely during visual field testing. The use of face masks causes additional problems in obtaining reliable perimetry results, especially if poorly fitting face masks are not adequately sealed.

Understanding the effects of face masks on the perimetry test and minimizing them is very important in obtaining reliable visual field tests and eliminating misinterpretations. This is the first original research investigating the impact of face masks on the visual field test so far to the best of our knowledge. Herein, we investigate the effects of face mask use on standard automated perimetry (SAP) results in glaucoma patients.

MATERIALS AND METHODS

This is a single-center prospective observational study that includes all followed up glaucoma patients who underwent SAP between May 1 and October 2, 2020. To minimize the low SAP reliability associated with the learning curve, only follow-up patients with previous SAP experiences were included. Only their initial examinations were used for the study. Recently diagnosed glaucoma patients with diagnosis-durations of <12 months and/or with <2 visual field test experiences in their history were excluded. We applied criteria for glaucoma classification previously described by the European Glaucoma Society Terminology and Guidelines for Glaucoma. The study protocol was approved by the Local Ethics Committee (128394345), and it was conducted by the principles of the Declaration of Helsinki. Informed consent was obtained from all patients before included in the study.

A total of 127 followed up glaucoma patients who underwent SAP were included in the study. The demographic data and a detailed ophthalmic examination of the patients were noted, including age, sex, type and duration of glaucoma, best-corrected visual acuity, refractive errors, intraocular pressure (IOP), IOP-lowering medications, anterior segment examination, gonioscopy, the optic nerve head, and macula examination. Pachymetry, parapapillary
retinal nerve fiber layer (RNFL), and visual field tests were evaluated in all patients. IOP was measured by Goldmann applanation tonometry. Pachymeter was measured by OcuScan RxP Measuring System (Alcon Inc., Irvine, CA), SAP was performed by Humphrey Field Analyzer 24-2 SITA-Fast test (Carl Zeiss Meditec AG, Jena, Germany). The patients’ refractive error corrections were made by inserting lenses into the SAP’s manual trial lens holder. The RNFL was assessed from high-definition spectral-domain optical coherence tomography (OCT) (Cirrus HD-OCT; Carl Zeiss Meditec AG).

Types of face masks used by the patients, the presence of fogging in the eyeglasses before the SAP, the face mask position after the SAP, and the presence of fogging on the perimeter lens after the SAP were noted at the end of the test by the visual field technicians (Hazine Kaplan and Serpil Demir). In all patients with low test reliability and/or visual field changes, SAP was repeated after repositioning the face masks and taping the upper edge of theirs on the nose’s bridge with a hypoallergenic medical bandage. In the repeated SAP, if there is an improvement in the patients’ reliability parameters and visual field defects, it was considered that these situations are related to the face masks.

Data were analyzed using SPSS for Mac OS, version 26.0 (SPSS Inc., Chicago, IL). Quantitative variables were expressed as mean and SDs. Frequencies and percentages were used for the categorical variables. The Fisher exact test compared the difference in the distribution of categorical variables. The Spearman correlation test was used to determine the correlations among the variables. A binary

![Figure 1](https://example.com/figure1.png)

**FIGURE 1.** Results of standard automated perimetry performed without (A, B) and with (C, D) face mask taping show the face mask’s effects in increase fixation losses and false-positive errors.
A logistic regression model was used to identify the influence of variables on the low SAP reliability. A $P$-value $<0.05$ was considered statistically significant.

**RESULTS**

This study includes 59 female (46.5%) and 68 male (53.5%) patients. The mean age was $59.8 \pm 10.3$ years (range: 34 to 84 y). The mean duration of glaucoma diagnosis was $46.1 \pm 16.0$ months (range: 13 to 90 mo). The mean best-corrected visual acuity was 20/25 (range: 20/40 to 20/20). The glaucoma types were primary open-angle glaucoma in 101 patients (79.5%), secondary open-angle glaucoma in 21 patients (16.5%), and angle-closure glaucoma in 5 patients (4%). Topical IOP-lowering medications included prostaglandin analogs in 58 patients (45.7%), fixed combinations in 41 patients (32.3%), and maximum topical therapy in 28 patients (22%). The mean IOP was $15.1 \pm 3.2$ mm Hg (range: 9 to 29 mm Hg). The mean central corneal thickness was $544.6 \pm 29.8 \mu m$ (range: 485 to 615 $\mu m$). The mean vertical cup-to-disc ratio was $0.7 \pm 0.07$ (range: 0.56 to 0.89). The mean of the average, superior, inferior, nasal, and temporal RNFL thickness was 79.3 ± 16.6, 64.4 ± 14.8, and $57.6 \pm 13.6 \mu m$, respectively. The mean values of Humphrey mean deviations and pattern standard deviations were $-5 \pm 2.9$ dB (range: $-13$ to 3.1 dB) and 3.7 ± 2.1 dB (range: 1.0 to 12.1 dB), respectively.

**FIGURE 2.** Results of standard automated perimetry performed without (A, B) and with (C, D) face mask taping show inferior visual field artifacts with good standard automated perimetry reliability, which may mimic pathologic field defects and misinterpretations.
On the basis of complete ocular examination, SAP and OCT findings, the progression of glaucoma was observed in 6 patients; topical IOP-lowering treatment was changed in 4 patients, and trabeculectomy surgery was performed in 2 patients who received maximal medical therapy.

The patients wore either ear-loop surgical face masks or ear-loop cloth face masks that had no nose wires. While 101 patients (79.5%) wore surgical face masks, 26 of the patients (20.5%) wore cloth face masks. Sixty-nine eyes of 41 patients (32.3%) were pseudophakic. Approximately two thirds of the patients (66.1%) were wearing eyeglasses due to refractive errors. The face mask–related low SAP reliability appeared in 23 patients (18.1%) (Fig. 1). The lower visual field defects were revealed in 3 patients (2.4%) (Fig. 2), but there was no evidence of progression in the ocular examinations and OCT findings in these patients. Low SAP reliability was significantly higher in cloth face masks than surgical face masks (47.8% vs. 9.9%; \( P = 0.0001 \)). Among these patients, the visual field technicians realized at the end of the test inappropriate face mask position in 2 patients (1.6%) and face mask–related fogging on the perimeter lens in 13 patients (10.2%). Nine of these 13 patients wore eyeglasses, and all showed face mask–related fogging on their eyeglasses before the SAP. In contrast, when all 84 patients wearing eyeglasses were evaluated, the visual field technicians only noticed face mask–related glasses fogging before the SAP in 28 of them (33.3%). The presence of face mask–related eyeglasses’ fogging before the visual field test had a statistically significant predictive value for the low SAP reliability (odds ratio: 27.95% confidence interval: 5.48-132.92, \( P = 0.0001 \)). There was no correlation among age (\( P = 0.643 \)), sex (\( P = 0.754 \)), and low SAP reliability or visual field artefacts. There was no significant difference between both eyes regarding the frequency of the face mask–related low SAP reliability (\( P = 0.853 \)). After taping the upper edge of masks on the nose bridge, fixation losses and false-positive errors were significant improvements (for both, \( P = 0.001 \)). False-negative errors did not show any significant change (\( P = 0.78 \)) (Fig. 3).

**DISCUSSION**

The present study emphasizes the effects of face mask use on SAP results in glaucoma patients. In this study, we saw the face mask–related SAP problems in 20.5% of patients. Although these problems were mostly associated with low SAP reliability, the lower visual field artifacts had also appeared in 3 of our patients. Young et al6 previously reported a case with similar visual field defects of our patients. After they reposition the patient mask, pinch down its nasal strip, and sealed it with the loops secured around the ears, the visual field defects disappeared in the repeated SAP. In this technique, there is no way to pinch down the nasal mask strip if they have no nose wire as in cloth masks, and it is uncertain whether the method will prevent the mask from riding up the face during SAP. Besides, we know from our previous experiences of the fogging oculars of the surgical microscope that this method does not always work. These artifacts may be related to small amounts of condensate or mask slippage. We noticed in 2 of our patients who had inferior visual field artifacts that the face masks slide up at the end of the tests. This study showed that the probability of the low SAP reliability was 27 times higher in patients with face mask–related fogging of eyeglasses before the visual field test. This result means that face mask–related fogging of the eyeglasses before the SAP is a strong predictor of fogging the trial lenses during the SAP. The most important point is which intervention can be more helpful in reducing these effects on SAP. A practical method to prevent fogging of the eyeglasses...
can also prevent the trial lens from fogging. Figure 4 shows how the fogging disappeared after taping in a patient with fogging of the eyeglasses before the SAP. These results show that the proper positioning of the face masks and applying a hypoallergenic medical bandage on the upper edge of masks on the nose’s bridge is an effective method to eliminate fogging-related visual field errors in all patients undergoing SAP. This method protects the visual field from errors associated with the face mask and reduces infectious contaminations that may develop during exhalation. After this study was concluded, we routinely started bandaging the face masks in the appropriate position for all patients who underwent the SAP in our clinic.

Although better reliability parameters can be expected in secondary SAPs due to the visual field learning curve, we have minimized this possibility by taking only follow-up patients who have glaucoma diagnosis-durations of >12 months and at least 2 visual field test experiences to the study. Further, a positive correlation between patients with fogging on the perimeter lens at the end of the test and low SAP reliability supports this idea. We would also like to emphasize that the lack of fogging on the perimeter lens at the end of the test does not mean that they were not fogged during the test. Indeed, our technicians detected fogging in about half of the patients with the face mask–related visual field errors.

The face mask–related low SAP reliabilities only increase the workload and primarily cause fixation losses and false-positive errors. These problems can be solved easily with the method mentioned above. However, the visual field artifacts with good SAP reliability, which may mimic pathologic field defects, may lead to misinterpretation suggesting IOP-lowering therapy is inadequate (Fig. 2). In these patients, confirming visual field abnormality in repeated visual field tests with the taped mask and careful assessment of structure (disc photos, and RNFL)-function correlation is very important. Indeed, we did not notice any progression in the ocular examinations and OCT findings in our patients with inferior visual field defects. These defects disappeared in the repeated SAP with the taped masks.

Homemade and cloth face coverings are becoming increasingly common, and they do not have nose wires. This situation leaves a potential gap at the edges of the nose wings, which may be more prone to causing condensation on the perimeter lens. Indeed, the present study showed that the face mask–related low SAP reliabilities were significantly higher in cloth face masks than surgical face masks (47.8% vs. 9.9%; \( P = 0.0001 \)). Another critical point is that personal protective equipment can be designed to fit the males’ face, so they may not be suitable for females and may more effects on SAP results in women. However, there was no correlation between sex and SAP errors in our study (\( P = 0.754 \)). This result may be related to our study’s small sample size due to the reduced patient flow during the COVID-19 pandemic.

The small sample size has a potential limitation of the study. However, the development of mask-related visual field problems in almost one fifth of the patients clearly shows that preventive methods should be taken before the visual field tests.

**FIGURE 4.** The appearance before taping the cloth mask in a patient with fogging on his eyeglasses and low standard automated perimetry reliability which the visual field technician realized fogging of the trial lenses at the end of the test (A) and the fogging of the eyeglasses disappeared after taping (B). The patient showed good test reliability in the repeated visual field test. Figure 4 can be viewed in color online at www.glaucomajournal.com.
CONCLUSIONS
Poorly fitting face masks can cause either visual field artifacts, which may be interpreted as glaucoma progression or low SAP reliability. The main effect of the face masks on SAP reliability is to increase fixation losses and false-positive errors. Careful assessment of structure-function correlation and repeated visual field tests with the taped mask are critical to differentiate between artifacts and abnormalities. The outcomes of this study suggest routinely bandaging the face masks in the appropriate position for all patients who underwent the SAP. This technique allows both to obtain a more reliable visual field test and to reduce infectious contaminations.

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