Original Article

Evaluating the Effect of Surgical Face Mask on Choroidal Thickness

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ABSTRACT

Purpose: To evaluate the choroidal thickness in healthcare professionals using a surgical face mask.

Study Design: Cross sectional study.

Place and Duration of Study: Ittefaq Hospital, Lahore, and Sohail's Oculab from June 2023 to July 2024.

Method: Sixty healthcare professionals aged 25–45 years with best corrected visual acuity of 6/6 or 6/9 and normal intraocular pressure (12–21 mmHg) were included. Participants with any systemic or ocular pathology were excluded. The instruments used in this study included a distance Snellen chart, an air-puff tonometer (Topcon), and a swept-source OCT device (Topcon DRI OCT Triton 3D). A self-structured proforma was used for data collection. Choroidal thickness was measured after wearing a surgical face mask for at least 4 hours and again 30 minutes after mask removal using swept-source OCT.

Results: The study included the right eyes of 60 participants in which there were 34 males (58.3%) and 26 females (41.7%). The mean age was 30.35 ± 4.90 years. A paired-sample t-test showed a statistically significant change in choroidal thickness between 4 hours of mask wearing and 30 minutes after mask removal ($p < 0.001$).

Conclusion: The findings showed a significant difference in choroidal thickness when wearing a surgical face mask compared with not wearing one. Prolonged mask use may cause hypercapnia, which can increase retinal vessel diameter and blood flow, leading to increased choroidal thickness.

Keywords: Choroid, Hemodynamics, Hypercapnia, mask, Optical Coherence Topography.

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INTRODUCTION

Choroid is a vascular layer of the eye located between retina and sclera, and it is mainly composed of small arteries, veins, and a dense capillary network.[1]Choroid forms part of the uveal tract along with the iris and ciliary body and consists of the choriocapillaris, Sattler's layer, Haller's layer, and the outer suprachoroidal layer, while Bruch's membrane separates it from the retina.[2]Itsupplies nutrients to the retina, macula, and optic nerve, regulates retinal temperature, helps maintain intraocular pressure, and absorbs stray light to improve visual quality.[3]RPE, retinal photoreceptors or the outer retina both receive blood from it.[4] Many diseases that impair vision, such as central serous chorioretinopathy and high myopia-related chorioretinal atrophies, are caused by the choroid.[5]In high myopia, early pathological changes commonly occur in the choroid, and choroidal thickness is therefore considered an important indicator of disease progression.[6]

Surgical masks, also called medical or procedural masks, are used to protect healthcare workers from bodily fluid exposure and are approved by the FDA as medical devices.

Surgical masks have 3 parts; pleated rectangular mask, nosepiece cable, tie or earring.[7]There are three layers. The outer fluid-repellent layer repels liquid and reduces the possibility that bacteria and viruses from the air may adhere to the mask. Middle layer of high-

efficiency filter is responsible for the labor-intensive task of consuming bacteria and viruses. The inner layer's ability to absorb moisture lowers the likelihood of bacteria or mucus to escape from the face mask when the user coughs or speaks.[8]Medical mouth-nose protection (MNP), commonly known as a surgical mask, is produced under specific industrial standards to ensure effective infection control.[9]

Headaches experienced during long-term mask use may be related to changes in cerebral hemodynamics caused by hypoxemia and carbon dioxide retention, especially in users of N95 masks.[10]Prolonged mask use may alter oxygen and carbon dioxide exchange, potentially affecting ocular blood flow (Figure 1). Although international studies have explored mask-related changes in choroidal thickness, there is limited data from Pakistan, which justifies the need for this study. Surgical face mask is frequently used in allied health professionals to prevent them from diseases. Healthcare professionals typically wear surgical masks for 5–6 hours per day, and although this protects them from infections, prolonged mask use may influence choroidal thickness due to physiological changes. Normal choroidal thickness (CT) in healthy subjects is about 250 to 350 μm, which differs based on a variety of variables, including gender, age, refractive error, as well as diurnal variation. This study will provide local data which can help in devising policies based on our local evidence.

METHODS

A descriptive cross-sectional study was conducted at Ittefaq Hospital Lahore and Sohail's Oculab from June 2023 to July 2024 after approval by the Institutional Review Board **(TUF/IRB/235/23)**. Healthcare professionals aged 25–45 years with best corrected visual acuity of 6/6 or 6/9, either gender, and normal intraocular pressure (12–21 mmHg) were included. A total of 60 right eyes were selected through purposive sampling. Participants with any systemic or ocular pathology were excluded. The instruments used in this study included a distance Snellen chart, an air-puff tonometer (Topcon), and a swept-source OCT device (Topcon DRI OCT Triton 3D).

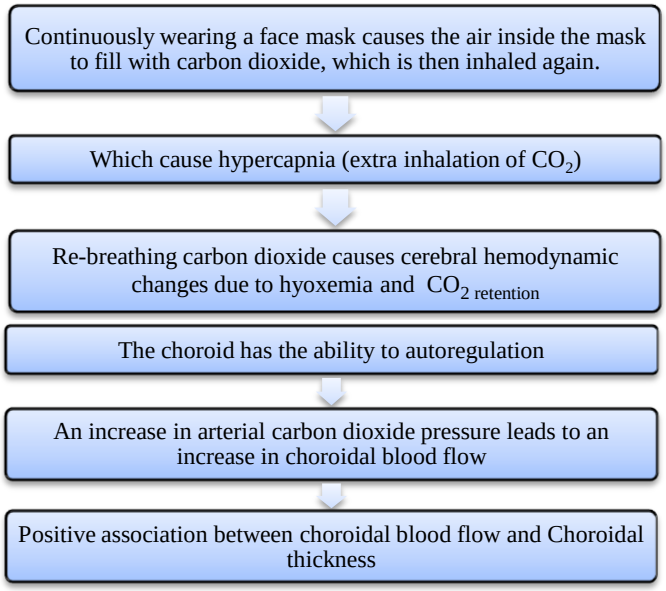

Figure 1: Effect of face mask on Choroidal thickness.

A self-structured proforma was used for data collection. Both verbal and written informed consent was obtained from all participants. Visual acuity was assessed, followed by choroidal thickness measurement using swept-source OCT. Choroidal thickness was measured twice: after wearing a surgical mask continuously for 4 hours and again 30 minutes after mask removal. The data were analyzed using IBM SPSS Version 20.

RESULTS

This study included 60 eyes of 60 health care professionals who were asked to participate in the study and all of them agreed. Response rate was 100%. Participants of 25- 45 years were included in the study.There was no gender specification. The mean

Table 1: *Paired Samples Test.*

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Choroidal thickness with surgical face mask - choroidal thickness without surgical face mask	33.63	22.79	2.94	27.74	39.52	11.43	59	0.000

difference between the choroidal thickness of the right eye with a surgical face mask and one without the face mask was 33.63±22.79µ.When using a surgical face mask, the mean choroidal thickness was 335.27 ±56.35µ. Thirty minutes after mask removal, the mean choroidal thickness was 301.63±52.51µ.

DISCUSSION

Optical coherence Tomography (OCT) was introduced in 1991 and has the ability to instantly provide a cross-sectional view of retina and its layers.[11,12]Swept Source (SS-OCT) can use longer wavelengths (1040 to 1060 nm) to evaluate deeper tissues including choroid, its layers and even retrobulbar tissues.[13,14]Age related macular degeneration, the pachy-choroid spectrum of disorders, diabetic retinopathy, and inflammatory vitreoretinal pathologies are only a few of the conditions for which SS-OCT has been used.[15]Recently it has been used to measure choroidal thickness which has opened new spectrum of disease pathology.[16] Studies have confirmed that choroid contains many layers, including Bruch's membrane, the choriocapillaris, Sattler's layer, Haller's layer, and the suprachoroidal lamina which are affected in different ocular conditions.[17]

In 2022 Kurt et al, estimated choroidal thickness (CT) in health care professionals who utilized surgical mask versus FFP2 masks usingenhanced depth-imaging OCT.[18] They divided 120 healthy volunteers into two groups. Group 1 wearing a surgical mask and Group 2 wearing an FFP2 mask. EDI-OCT was used to measure the choroidal thickness before wearing mask at 8:30AM, and after removing it for lunch at 12:30PM. After 4 hours of wearing masks, CT of Group 1 was increased for sub-foveal CT, CT1500 (CT at a point1500 µm temporal to the foveal center) and CN1500 (CT at 1500 µm nasal to the foveal center). However, the increase was not statistically significant. After using the mask for 4 hours, in Group 2, the rise in sub-foveal CT was statistically significant ($p = 0.001$). However, the increase in CN1500 and CT1500 ($p = 0.162$ and $p = 0.058$, respectively) were not.

Gunay B et al, (2022) investigated short-term ocular changes in healthy adults wearing FFP2/N95 masks. Fifty-three volunteers underwent OCT imaging at baseline, after 4 hours of mask use, and one-hour post-removal. Retinal thickness, RNFL, and ganglion cell layer thickness showed no meaningful change. Choroidal thickness increased in almost all examined regions after 4 hours of mask wear, with values returning to baseline after mask removal except in a few temporal and inferior sectors. Pulse rate decreased significantly at 1 and 4 hours, and its change correlated with the increase in choroidal thickness. The authors concluded that FFP2/N95 masks may enhance parasympathetic activity, leading to transient choroidal thickening in healthy individuals.[19] Similarly, Gündoğan compared the impact of N95 respirators and surgical masks on choroidal thickness in 52 healthy eyes. Participants had normal vision, intraocular pressure, and axial length. Over a 4-hour period, both mask types produced a measurable increase in choroidal thickness. The change was statistically greater with N95 use (from 366.73 ± 70.81 µm to 381.23 ± 69.29 µm, $p = 0.001$), while surgical masks also caused a smaller but significant rise (from 366.78 ± 71.00 µm to 372.58 ± 76.56 µm, $p = 0.031$).[20]

It was further highlighted that vascular and stromal alterations within the choroid were associated with prolonged N95 mask use in healthcare workers.[21] Using enhanced depth imaging OCT, measurements were taken after two continuous hours of mask wear and repeated one hour after removal. All changes were statistically significant ($P < 0.05$). The study demonstrated a marked increase in overall choroidal thickness ($p = 0.00$) with sustained mask use, similar to the effects noted with prolonged surgical mask wear. The authors suggested that uninterrupted mask usage may lead to mild hypercapnia, increasing choroidal blood flow and consequently thickening the choroid. These findings provide additional insight into how continuous face mask wear may influence choroidal physiology.

The results of our study support the existing data in our healthcare settings suggesting significant difference in choroidal thickness with both face mask wear and without face mask. Thelong term, usage of surgical face mask cause hypoxia and hypercapnia which leads to increase in retinal blood flow.

The key clinical implication is that prolonged face mask use may transiently alter choroidal thickness, which could be relevant when interpreting OCT findings in conditions where choroidal stability is important, such as central serous chorioretinopathy, age-related macular degeneration, diabetic choroidopathy, and glaucoma. Clinicians should consider recent mask wear as a potential physiological

confounder when evaluating choroidal thickness measurements.

This study has several limitations. First, the sample size was relatively small. Second, only short-term effects of mask wear were assessed, and long-term physiological changes could not be determined. Third, although hypoxia and hypercapnia were proposed as possible mechanisms, no direct measurements of oxygen saturation or carbon dioxide levels were performed. Choroidal thickness is also influenced by physiological factors such as diurnal variation, hydration status, and systemic parameters, which may not have been fully controlled. Additionally, individual differences in mask fit and breathing resistance may have contributed to variability in the observed responses. Finally, participants were healthy individuals without ocular or systemic disease, which restricts the applicability of these results to patients with common comorbidities.

CONCLUSION

Prolonged surgical face mask use appears to induce mild hypoxia and hypercapnia, contributing to increased choroidal thickness through enhanced retinal blood flow.

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Patient's Consent: Researchers followed the guidelines set forth in the Declaration of Helsinki.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board**(TUF/IRB/235/23).**

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