



# Association of Choroidal Thickness with Sleep Deprivation in Night-shift Healthcare Workers

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## Abstract

**Background:** Good vision is an important factor for most night-shift personnel, and the effects of sleep deprivation on visual function must be studied. Up to our knowledge, no study has evaluated the effect of night working on choroidal indices.

**Objectives:** In this study, we aimed to investigate the effects of sleep deprivation on choroidal thickness.

**Methods:** This cross-sectional study was conducted on 50 night-shift healthcare workers of the Islamic Republic of Iran (IRI) army medical core. Baseline choroidal thickness was measured for all participants using optical coherence tomography (OCT), and at the same time (10 AM to 2 PM) a day following the night shift, participants underwent a second measurement of choroidal thickness. The awake time before the second measurement was recorded.

**Results:** The mean age  $\pm$  standard deviation of the participants was  $42.55 \pm 5.52$  that 52% were female. A statistically significant increase in choroidal thickness was recorded following night-shift ( $P = 0.001$ ). Choroidal thickness following night-shift significantly correlated with age ( $r = -0.614$ ;  $p = 0.001$ ), awake time ( $r = 0.417$ ;  $P = 0.003$ ) and with baseline thickness of choroid ( $r = 0.830$ ;  $P = 0.001$ ).

**Conclusions:** It seems that sleep deprivation may increase choroidal thickness, and the awake time may be a predictor of choroidal thickness change after the night shift.

**Keywords:** Sleep Deprivation, Choroidal Thickness, Night-shift, Healthcare Workers

## 1. Background

Choroidal tissue is the lining of the posterior eye, which is placed between the retina and the sclera. This tissue probably has a role in eye growth and developing refractive errors of the eye (1, 2). Animal studies have shown that in the process of developing refractive errors, choroidal changes occur rapidly following scleral growth (3-5). Several studies have reported that hyperopia occurs due to slow eye growth and is associated with choroidal thickening, whereas rapid eye growth that results in myopia is associated with thinning of the choroid (6-9). These results are suggestive that choroidal thickness changes are one of the primary findings during the development of refractive eye disorders (9).

Choroidal thickness undergoes diurnal changes throughout the day, which has been reported by both animal and human studies (10, 11). It is believed that these variations in thickness are related to light exposures and circadian rhythms (12). Literature has shown that the choroid typically is in its minimum thickness during the

day gradually reach its thickest at night (10-13).

There has always been a demand for 24-hour availability in some occupations such as health care, military, security, etc. This disruption of social and biological rhythm in night-shift workers has been shown to increase the risk of various diseases (14-16). Evidence suggests an association between night work and metabolic disorders, coronary heart disease, and cancer (17).

Previous studies showed that choroidal thickness may follow a circadian rhythm probably affected by the cortisol cycle. On the other hand, there is a spectrum of retinal diseases known as the "pachychoroid spectrum" that is associated with a choroidal thickening. Several studies have shown stress, sleep disorders, exogenous or endogenous hypercortisolemia are risk factors for pachychoroid diseases. Furthermore, sleep deprivation leads to an increased serum level of cortisol on the next day of insomnia. However, up to our knowledge, there is no study evaluating the effects of the night shift on choroidal measurements.

## 2. Objectives

In this study, we aimed to investigate the effects of the night shift on the choroidal thickness of healthcare workers.

## 3. Methods

This cross-sectional study was conducted on night-shift healthcare workers of Islamic

Republic of Iran (IRI) army medical core. For the sample population, 50 night-shift workers who at least had nine-hour awake time during the night shift were selected. The participant had to be healthy without underlying diseases, with no history of smoking or caffeine consumption during the previous 48 hours, and not a corticosteroid consumer. All participants were provided written informed consent before the study. The study design and implementation were all in accordance with the tenets of the Declaration of Helsinki (ethics code: IR.AJAUMS.REC.1399.203).

After collecting demographics of age and gender, the participants underwent a complete ophthalmology examination, and baseline choroidal thickness from Bruch's membrane to the choroido-scleral junction was measured for all participants using optical coherence tomography (OCT). The baseline measurement was done on a routine day. The second measurement was performed in the morning following the night shift. Both baseline and after night-shift measurements were done between 10 AM and 2 PM. Also, the awake time before the second measurement was recorded.

All data were introduced into Statistical Package for Social Sciences, version 26.0 (IBM Corp, Armonk, NY, USA) for statistical analysis. Paired *t*-test was used to compare choroidal thickness before and after the night shift. Pearson correlation test was used to investigate the relation of choroidal thickness with age, sex, and awake time. The level of significance was set at a  $P < 0.05$  throughout the study.

## 4. Results

Fifty night-shift healthcare workers from IRI army medical core with the mean age  $\pm$  standard deviation (SD) of  $42.55 \pm 5.52$  participated in the study. Moreover, 52% of the participant were female. In the initial ophthalmology examination, no specific disorder was found in any of the subjects.

The mean awake time before the second measurements of choroidal thickness was  $12.3 \pm 2.33$  hours with the minimum and maximum of 9 and 16 hours, respectively. The mean choroidal thickness at baseline was  $394.49 \pm$

$12.72 \mu\text{m}$ , and the mean for choroidal thickness after night-shift was  $437.19 \pm 22.68 \mu\text{m}$ . This increase in choroidal thickness was statistically significant ( $P = 0.001$ ). There was no significant difference in choroidal thickness between sexes ( $P = 0.117$ ).

Pearson correlation analysis showed choroidal thickness following night-shift correlated with age ( $r = -0.614$ ;  $P = 0.001$ ), awake time ( $r = 0.417$ ;  $P = 0.003$ ), and with baseline thickness of choroid ( $r = 0.830$ ;  $P = 0.001$ ). No significant association was found between the time of the second measurement and choroidal thickness ( $r = 0.021$ ;  $P = 0.887$ ).

## 5. Discussion

A study in 2007 reported that about 20% of the workforce worked in the night-shifts (18). This percentage is increasing due to societal and economic demands for 24-hour availability in various settings (16). Many epidemiological studies have found night work to be a major risk factor for a variety of disorders, including cardiovascular diseases, metabolic syndrome, diabetes, or even cancer (17). In this study, we evaluated the changes in choroidal thickness before and after night shift.

We have reported that choroidal thickness significantly increases after the night shift compared to a normal day. Also, a positive correlation was recorded between the awake time and choroidal thickness. A significant relationship was also recorded between choroidal thickness changes after a night shift and the baseline measurements of the choroid.

Ostrin reported the mean choroidal thickness in children  $541.13 \pm 8.26$ , which is much higher than our mean (19); it is expected as we showed a negative correlation between age and choroidal thickness. Our average choroidal thickness measures are consistent with previous studies measuring the choroidal thickness in healthy human eyes (20-23). Shahbaz et al. studied the choroidal thickness changes in patients with primary insomnia (24). They reported significant thickening in the choroidal layer in these patients comparing to healthy controls. Also, they reported that age and severity of insomnia are predictors for choroidal thickness. In our study, we have reported that those night-shift workers who suffered a short time of sleep deprivation also had a thickening of the choroid layer.

The choroid layer is established to go under diurnal changes of thickness, and daily rhythms of light exposure have a major effect in regulating these circadian rhythms (25). One of the suggested mechanisms in literature is that the light induces an increase in the dopaminergic neurons of the retina, which leads to the release of nitric oxide and consequently vascular dilation and choroidal congestion

(20, 26, 27). On the other hand, serum cortisol is highly affected by the circadian rhythm and has a key role in the choroidal thickness (28). Several studies have reported the effect of cortisol on the choroidal thickness and associated diseases like patchy-choroid spectrum diseases. This study confirms this hypothesis that sleep deprivation may induce choroidal thickening probably by increasing serum cortisol and make the people susceptible to some chorioretinal diseases. This should be considered in future studies to evaluate choroidal thickness in various diseases such as age-related macular degeneration (AMD), central serous chorioretinopathy (CSCR), polypoid choroidal vasculopathy (PCV). However, we did not measure the serum level of cortisol, and further large studies are required to assess this correlation.

### 5.1. Conclusions

It seems that sleep deprivation may increase choroidal thickness, and the awake time may be a predictor of choroidal thickness change after the night shift.

### Footnotes

**Authors' Contribution:** A.T: Original idea and data gathering; K.S: analyzing data, A.M: Writing the manuscript; K.K: Revision of the manuscript for important intellectual content.

**Conflict of Interests:** The authors declare they have no conflict of interest.

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**Informed Consent:** Written informed consent was obtained from all participants before the study.

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