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Original Research

# Evaluation of Cornea and Anterior Chamber Results of Patients with Obstructive Sleep Apnea Syndrome

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**ABSTRACT**

**Objective:** To evaluate the anterior segment findings measured via corneal topography of patients with obstructive sleep apnea syndrome (OSAS) and to compare the findings with normal subjects.

**Methods:** A total of 43 eyes from 43 patients with OSAS and 43 eyes from 43 healthy persons who were referred to eye clinics from 2012 to 2016 were randomly selected and included in this retrospective study. Routine eye examination and anterior segment findings measured via corneal topography were recorded for both groups. Central corneal thickness (CCT), keratometry values (K1, K2, and Kmax), corneal volume (CV), anterior chamber depth (ACD), anterior chamber volume (ACV), and anterior chamber angle (ACA) of the two groups were compared.

**Results:** The mean CCT values of the control and OSAS groups were 567.23±31.17 and 544.4±36.44 (p=0.002), respectively. The mean CV (HR) was found to be 60.51±8.44 in the control group and 59.78±3.47 in the OSAS group (p=0.04). There was no statistically significant difference between the OSAS and control groups in terms of mean age, K1, K2, Kmax, ACV, ACD, and ACA (p>0.05). The mean apnea/hypopnea index (AHI) score of the OSAS group was found to be 21.82±12.79. There was no negative or positive correlation between the AHI score and age, CCT, K1, K2, Km, SCL, SCL, SCA, and CV.

**Conclusion:** Central corneal thickness and CV are lower in OSAS patients than in normal people.

**Keywords:** Obstructive, sleep apnea, anterior segment of the eye, topography

## INTRODUCTION

Briefly put, obstructive sleep apnea is the partial or complete occlusion of the upper respiratory tract at regular intervals and recurrently during sleep. These periods of obstruction are a significant cause of disruption of patient comfort. These periods can cause chronic fatigue and cognitive impairment in daytime hours in patients (1). It is thought to affect between 3-7% of the population with varying frequency (2). Polysomnography, which calculates the number of apneas that occur during the night, is the most important diagnostic test for obstructive sleep apnea (3). Obstructive sleep apnea is thought to be a risk factor for various eye disorders due to hypoxia caused by the periods of apnea in the body. These include glaucoma, flexible eyelid syndrome, optic neuropathy, and keratoconus (4-6).

In previous studies, the frequency of clinical conditions such as papilledema and optic neuropathy (7), retinal vascular tortuosity, and congestion increase (8) have been investigated in patients with obstructive sleep apnea syndrome (OSAS). In a study conducted, 69 patients with obstructive sleep apnea had a glaucoma incidence of 7.2% (9). In another study, it was shown that the incidence of primary open-angle glaucoma was higher in patients with sleep apnea syndrome (10).

On the other hand, in another study, sleep apnea patients and healthy subjects were compared and there was no significant difference between the two groups in terms of anterior chamber findings such as anterior chamber depth, anterior chamber volume, and anterior chamber angle (11). Patients with severe sleep apnea have been shown to have increased eyelid laxity, higher Schirmer test scores, and reduced tear breakup time compared to healthy subjects (12).

Obstructive sleep apnea syndrome is associated with many eye diseases as mentioned above. We are of the opinion that anterior segment parameters may be affected by mechanisms such as hypoxic damage and increased sympathetic activation due to OSAS. For this reason, we aimed to compare the anterior segment findings of sleep apnea patients with those of healthy individuals and to see if there is any difference between the groups with mild, moderate and severe sleep apnea syndrome.

## METHODS

Forty-three eyes of 43 patients with sleep apnea (38 males, five females) who presented to the ophthalmology clinic between 2012 and 2016 were randomly included in the study. Forty-three eyes of 43 healthy individuals matched according to age and

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sex were included in the study. The study was approved by the Pamukkale University Medical Ethics Committee and the standards in the Helsinki Declaration were adhered to (Ethics Committee approval: 10.01.2017 dated and numbered 01).

Autorefractometric values, visual acuity, intraocular pressure measurements, fundus examinations, and topographic measurements of a randomly selected eye of the patients were recorded. Patients who had undergone intraocular surgery, had pterygium or a disease other than sleep apnea, or had a refractive error of more than-1.50 and +1.50 diopters, were not included in the study. The keratometric (K1, K2, Kmax) and pachymetric (CCT) measurements of the patients with a Pentacam HR (Oculus, Wetzlar, Germany), their corneal volumes (CV), anterior chamber depths (ACD), anterior chamber volumes (ACV), and anterior chamber angles (ACA) were recorded. The keratometric values of the patients and the control group were examined in three different categories; namely K1 (horizontal keratometry measurement), K2 (vertical keratometry measurement), and Kmax (maximum keratometry measurement). The corneal volume was determined by measuring the area with a radius of 5mm from the apex. The Pentacam HR is a device that evaluates the anterior segment making elevation-based measurements with a rotating Scheimpflug camera. To measure the curvature of the cornea and its diopter equivalent, the device evaluates two large meridians perpendicular to each other in the 3.0 mm corneal circle. K1 and K2 with Pentacam represent the keratometric readings simulated on the horizontal and vertical meridians (13).

The participants were firstly divided into sleep apnea patients and the control group. After comparing the data from these two groups of patients, the patients were divided into three groups, namely mild, moderate and severe, according to the severity of the disease. Apnea-hypopnea index (AHI) scores were determined on the basis of the polysomnography of the patients. The mild group consisted of patients with an AHI score of between 5-15, the moderate group between 16-30, and those with scores over 30 were also classified as having severe illness.

**Statistical Analysis**

IBM Statistical Package for the Social Sciences version 21.0 (IBM SPSS Corp.; Armonk, NY, USA) was used for the statistical analysis. Continuous variables were expressed as mean±standard deviation, median (minimum and maximum values), and categorical variables in numbers and percentages. When the parametric test assumptions were met, the Significance of the Difference Between Two Means Test and One Way Analysis of Variance were used to compare the independent group differences, and when the parametric test assumptions were not met, the Mann-Whitney U Test and Kruskal Wallis Variance Analysis were used to compare independent group differences. In addition, the relations between numerical variables were examined with Pearson Correlation Analysis. P values below 0.05 were considered statistically significant.

## RESULTS

There was no statistically significant difference in the mean age, K1, K2, Kmax, anterior ACV, ACD, ACA findings between the sleep apnea group and the control group (p>0.05). The mean CCT of the control group was 567.23±31.17 and the same value was 544.4±36.44 in sleep apnea patients. This difference was statistically significant (p=0.002). The mean CV was found to be 60.51±8.44 in the control group and 59.78±3.47 in the sleep apnea group (p=0.04). The difference was statistically significant (p=0.04). The measured values of the two groups are shown in Table 1.

The average apnea/hypopnea index (AHI) score of sleep apnea patients was 21.82±12.79. There was no negative or positive cor-

**Table 1.** Measurement values of the control and OSAS groups

| | Control (n=43) | | OSAS (n=43) | | p |
|---|---|---|---|---|---|
| Age | 44.02±10.94 | 42 (25–67) | 44.02±10.94 | 42 (25–67) | 1 |
| AHI | – | – | 21.82±12.79 | 16 (5–56) | – |
| CCT | 567.23±31.17 | 560 (503–631) | 544.4±36.44 | 542 (451–645) | 0.002* |
| K1 | 42.67±1.68 | 42.2 (39.9–46.9) | 42.97±1.54 | 42.9 (40.1–46.2) | 0.384 |
| K2 | 43.54±1.73 | 43.3 (40.1–47.6) | 43.86±1.97 | 43.7 (40.3–51.4) | 0.476 |
| Kmax | 43.1±1.68 | 42.8 (40–47.2) | 43.4±1.71 | 43.2 (40,2–48.7) | 0.411 |
| ACV | 170.3±36.41 | 174 (97–243) | 162.63±39.04 | 161 (82–250) | 0.349 |
| ACD | 2.95±0.36 | 2.95 (2.27–3.77) | 2.87±0.32 | 2.85 (2.21–3.5) | 0.313 |
| ACA | 34.23±8.92 | 34 (17.1–54.4) | 33.64±6.6 | 35.1 (19.5–45.8) | 0.728 |
| CV | 60.51±8.44 | 61 (11.7–71) | 59.78±3.47 | 60.2 (51.8–66.8) | 0.04* |

*p<0.05 was considered statistically significant

OSAS: obstructive sleep apnea syndrome; AHI: apnea hypopnea index; CCT: central corneal thickness; K1: horizontal keratometric value; K2: vertical keratometric value; Kmax: maximum keratometric value; ACV: anterior chamber volüme; ACD: anterior chamber depth; ACA: anterior chamber angle; CV: corneal volume

**Table 2.** Correlation of apnea hypopnea index with other measurements

| | | Age | CCT | K1 | K2 | Kmax | ACV | ACD | ACA | CV |
|---|---|---|---|---|---|---|---|---|---|---|
| AHI | R | 0.233 | –0.041 | 0.113 | 0.142 | 0.129 | –0.120 | –0.139 | –0.102 | 0.007 |
| | p | 0.133 | 0.796 | 0.470 | 0.365 | 0.411 | 0.444 | 0.374 | 0.517 | 0.965 |

R: correlation coefficient

AHI: apnea hypopnea index; CCT: central corneal thickness; K1: horizontal keratometric value; K2: vertical keratometric value; Kmax: maximum keratometric value; ACV: anterior chamber volüme; ACD: anterior chamber depth; ACA: anterior chamber angle; CV: corneal volume

**Table 3.** Comparison of mild, moderate and severe OSAS groups with the control

| | Mild (n=15) | Moderate (n=16) | Severe (n=12) | Control (n=43) | p |
|---|---|---|---|---|---|
| Age | 43±9.81 | 41.31±9.87 | 48.92±12.78 | 44.02±10.94 | 0.317 |
| AHI | 9.63±3.86 | 20.59±4.98 | 38.7±7.5 | – | – |
| CCT | 541.8±43.3 | 555.13±22.63 | 533.33±40.94 | 567.23±31.17 | 0.007* |
| K1 | 42.65±1.57 | 43.18±1.53 | 43.11±1.57 | 42.67±1.68 | 0.634 |
| K2 | 43.33±1.58 | 44.08±1.72 | 44.23±2.64 | 43.54±1.73 | 0.606 |
| Kmax | 42.97±1.56 | 43.63±1.61 | 43.64±2.05 | 43.1±1.68 | 0.657 |
| ACV | 169.27±34.68 | 160.81±30.23 | 156.75±54.23 | 170.3±36.41 | 0.648 |
| ACD | 2.93±0.29 | 2.87±0.24 | 2.79±0.44 | 2.95±0.36 | 0.546 |
| ACA | 35.19±6.18 | 32.2±6.87 | 33.62±6.85 | 34.23±8.92 | 0.746 |
| CV | 58.91±3.79 | 61.76±2.17 | 58.22±3.46 | 60.51±8.44 | 0.003* |

*p<0.05 was considered statistically significant

AHI: apnea hypopnea index; CCT: central corneal thickness; K1: horizontal keratometric value; K2: vertical keratometric value; Kmax: maximum keratometric value; ACV: anterior chamber volüme; ACD: anterior chamber depth; ACA: anterior chamber angle; CV: corneal volume

relation between the AHI score and age, CCT, K1, K2, Kmax, ACV, ACD, ACA, and CV. Table 2 also shows the correlation between the AHI score and other characteristics of the patients.

There was a statistically significant difference between the four groups in the measurement of CCT when sleep apnea patients were classified as mild (AHI 5-15), moderate (AHI 16-30), and severe (>30), and compared with the control group (p=0.007). The CV showed a statistically significant difference between the four groups (p=0.003). Table 3 shows the measurement and p values of the four groups.

## DISCUSSION

Central corneal thickness and corneal volume were found to be statistically significantly lower in 43 patients with sleep apnea syndrome compared to the control group. The apnea/hypopnea score (AHI) of the sleep apnea patients does not correlate with the CCT and CV. There were no significant differences between the two groups in terms of other measurement results.

The mechanisms of ocular complications in obstructive sleep apnea syndrome are influenced by many factors. Hypercoagulability, the emergence of free oxygen radicals, increased oxidative stress, and endothelial dysfunction are some of these. Sympathetic activation and anoxic damage resulting in optic nerve involvement is one of the mechanisms emphasized in this syndrome (14, 15).

Obstructive sleep apnea syndrome is associated with various eye problems as mentioned earlier. For example, the relationship between keratoconus and sleep apnea has been shown in previous studies. In a study by Saidel et al. (5), the risk of sleep apnea in keratoconus patients was found to be higher. Woodward et al. (16) showed the relationship between keratoconus and sleep apnea and demonstrated it to be more frequent compared with the normal population. In addition, this relationship was found to be higher in severe keratoconus patients in the same study. In our study, although the measurements of corneal volume and central corneal thickness were low in patients with sleep apnea, no keratoconus was detected in any of the patients. The lack of a diagnosis of keratoconus may be due to the small number of patient groups involved in the study.

Central corneal thickness measurements did not show any statistically significant change in a study by Aslan Bayhan et al. (11) compared to normal subjects. On the other hand, in a study by Koseoglu et al. (17), the CCT values (542.14±31.21) of sleep apnea patients were found to be significantly lower than the healthy control group (569.92±13.46) and correlated with the severity of the

disease. Similarly, our study found that CCT was significantly lower when compared to the control group. However, according to our findings, this does not correlate with the severity of the disease.

Cornea volume has been shown to be significantly reduced in cases of keratoconus, which has been associated with the disease stage (18). Cornea volume was significantly lower in patients with sleep apnea than in the control group according to our study. As far as we have investigated in the literature, our study is the first to show this result. This parameter was not taken into account in the study by Koseoglu et al. (17) On the other hand, Aslan Bayhan et al. (11) did not find any change in the cornea volume or the measurements of the central corneal thickness compared to the healthy control group in their studies. We think that the most important cause of low CCT and cornea volume in OSAS patients is hypoxia. Increased matrix metalloproteinases in sleep apnea syndrome have been shown to be due to increased levels of IL-6 and TNF-alpha levels due to hypoxia (19). Matrix metalloproteinases have extracellular matrix regulatory properties. Therefore, the thinning of the cornea and decrease in cornea volume may be due to this. Defects in these biomechanical properties may also affect the CCT and cornea volume. We also think that hypoxia may affect the epithelium, stroma, and endothelium layers of the cornea, thereby altering the shape of the cornea through mechanisms such as edema or neovascularization in the stromal layer. The fact that central corneal thickness and the cornea volume are significantly lower in the patient group suggests that these two parameters are directly related to each other.

In this study, sleep apnea patients were compared with the control group both as a single group and by being divided into three groups according to the severity of the disease. Our goal here is to show how the severity of the disease affects the measurements. The values of CCT and cornea volume were significantly different in these four groups. However, there was no correlation between the AHI score indicating disease severity and these variables.

The biggest limitations of our study are the low number of patients and its retrospective nature. Another limitation is that the number of endothelial cells, one of the factors affecting corneal thickness, was not calculated. We think that there is a need for prospective studies where more patients are evaluated and endothelial factors are assessed.

## CONCLUSION

According to the results of the study, the values of CCT and CV were lower in the OSAS patients. It should be taken into account that CCT may be subtle in patients with sleep apnea, especially when it comes to intraocular pressure measurements. We think that it would be highly beneficial in terms of ocular health if physicians who manage patients with sleep apnea sent their patients to an ophthalmologist for ocular findings.

**Ethics Committee Approval:** Ethics committee approval was received for this study from the Ethics Committee of Pamukkale University (Approval: 10.01.2017).

**Informed Consent:** Due to the retrospective design of the study, informed consent was not taken.

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**Conflict of Interest:** The authors have no conflicts of interest to declare.

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