Evaluation of meibomian gland morphology and anterior segment parameters by Sirius topography systems in polycystic ovary syndrome

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Purpose: To compare findings in specular microscopy, corneal topography, and noncontact meibography in polycystic ovary syndrome (PCOS) patients with healthy controls. Methods: A total of 40 women with PCOS and 32 healthy controls were enrolled in the study. Schirmer’s test, Ocular Surface Disease Index (OSDI), noninvasive tear break-up time (NIBUT), the mean keratometry (Km), maximum keratometry (Kmax), central (CCT), thinnest (TCT) and apical (ACT) corneal thicknesses, meibomian gland (MG) loss, meiboscopes, morphology of MGs, endothelial cell density (ECD), coefficient of variation (CV), and percentage of hexagonal cells (PHEX) were analyzed. Correlations between anti-Mullerian hormone (AMH) and sex hormones and the findings of PCOS patients were evaluated. Results: Mean OSDI score, intraocular pressure, Km and Kmax values, the mean MG loss of upper and lower eyelids, lower eyelid meiboscore, and degree of morphological abnormalities of MGs were higher in cases with PCOS than healthy controls. There were no significant differences between groups in Schirmer results, first and average NIBUT, mean values of TCT, ACT, CCT, ECD, CV, and PHEX (P > 0.05, for all). There were correlations between plasma AMH level and Kmax, back Km and PHEX, and between estradiol (E2) and PHEX; there were negative correlations between E2 and total MG loss and CV and between total testosterone and ACT. Conclusion: Loss and morphological deterioration of the MGs are observed in PCOS patients, even if the tear parameters are not impaired yet. In eyes with PCOS, keratometry values become steeper in proportion to AMH levels. The PCOS patients should be followed carefully for the development of corneal ectasia.

Key words: Corneal topography, dry eye, keratoconus, noncontact meibography, polycystic ovary syndrome, sex hormones, specular microscopy

Sex hormones have been known to influence the anatomic and functional structures of the ocular surface.[1] Estrogen, progesterone, and androgen receptors have been found in the cornea, lens, iris, ciliary body, retina, lacrimal glands, meibomian glands (MGs), goblet cells, and conjunctiva.[2] Sex hormone dysfunction affects the severity and progression of dry eye.[3] Dry eye occurs predominantly in women, especially during menopause, pregnancy, and lactation.[4] It has been shown that dry eye symptoms were more severe in patients with polycystic ovary syndrome (PCOS), which is the most common endocrine disorder among women of reproductive age.[5] According to the Rotterdam definition, two of three criteria must be met to fit the definition of PCOS: chronic oligo-ovulation or anovulation, presence of hyperandrogenism, clinical hirsutism or elevated androgens in laboratory tests, and ultrasonographic polycystic ovarian appearance.[6] For the diagnosis of PCOS, practitioners were advised to check sex hormone levels.[7] Recent studies have shown that anti-Mullerian hormone (AMH) measurement was important for diagnosis and detection severity of PCOS.[8]

Infrared meibography allows the observation of MG structure and abnormalities such as loss, shortening, dilation, thinning, distortion, or tortuosity of the glands.[9] Although there have been studies on dry eye and MG function in PCOS patients in recent years, a limited number of studies have been conducted on the change in the meibography of these patients.[10,11] In this study, the aim is to evaluate the changes in MG morphology, corneal endothelial, and corneal topographic measurements in patients with PCOS. To the best of our knowledge, our study is the first to compare changes in specular microscopy, corneal topography, and noncontact meibography findings together in PCOS patients with healthy controls. In addition, correlations between AMH/MIS (anti-Mullerian hormone/Mullerian inhibiting substance), sex hormones, and the findings of PCOS patients were also evaluated.

Methods

This cross-sectional study was performed from April 2021 to September 2021 at the Department of Ophthalmology and at the Gynecology and Obstetrics clinic of a tertiary center. The study...
protocol was approved by the Institutional Review Board of the hospital in accordance with the tenets of the Declaration of Helsinki (2011-KAEK-25 2021/03-15). Written informed consent to participate in this study was obtained from the patients and healthy controls after explaining the nature and purpose of the study. Exclusion criteria included patients who were <18 or >40 years, blepharocconjunctivitis or a history of diagnosed dry eye disease that would influence MG architecture or interfere with tear film production and function, any systemic or ocular disease requiring daily medication including allergic, autoimmune or dystrophic diseases, a history of eye surgery, high spherical (≥5.0 D or ≥3 D) or cylindrical (≥ 2.0 D) refractive errors, history of contact lens wear, pregnancy, aqueous tear insufficiency, history of hypercholesterolemia or intake of lipid-lowering drugs, diabetes mellitus or any other systemic, neurologic, rheumatologic, or dermatologic disorder affecting the health of the ocular surface.

We evaluated 40 eyes of 40 consecutive women who were diagnosed with PCOS in accordance with the Rotterdam 2003 criteria and 32 eyes of 32 female healthy volunteers as a control group with no endocrine-related complaints or disorders. Participants had no history of contact lens use. Blood samples were collected from all subjects during the early follicular phase of the menstrual cycle. Plasma levels of the following circulating hormones were investigated: thyroid-stimulating hormone, prolactin (PRL), follicle-stimulating hormone (FSH), luteinizing hormone (LH), dehydroepiandrosterone sulfate, total testosterone (TT), and free testosterone, 17-hydroxy-progesterone (PRG), AMH/MIS, serum cholesterol, insulin, and glucose after 8 h of fasting.

A comprehensive ophthalmic examination, including best spectacle-corrected visual acuity, spherical equivalent (SE), intraocular pressure (IOP) measured by noncontact tonometry (CT.1P, Topcon, Japan), slit-lamp biomicroscopy, a dilated fundus examination was performed for all patients. Then, the Schirmer’s I test (without anesthesia), Ocular Surface Disease Index (OSDI) evaluation, corneal topography, noninvasive tear break-up time (NITBUT), noncontact meibography, and specular microscopy were performed.

**Corneal topographic examination**

First, NITBUT was performed with the Phoenix-tear film imaging module on the Sirius Topography device (CSO, Florence, Italy). The first break seen in the Placido ring was detected by the device and recorded as the first NITBUT, and the average duration of all corneal break-ups after blinking was recorded as the average NITBUT.

The corneal topography of the patients was done with the Scheimpflug camera system. Mean keratometry (Km) values for both front and back surfaces of the cornea, maximum keratometry (Kmax) value, central corneal thickness (CCT), thinnest corneal thickness (TCT), and apical corneal thickness (ACT) values were recorded from topographic analyzes. Meibography was performed with the Phoenix-Meibography Imaging software module. The upper and lower eyelids were everted, and five images were captured from the tarsal conjunctival surfaces. Images of the best quality of MG structures were selected. The MGs through infrared illumination of the everted eyelid was appeared as hyperlucent vertical clusters. A trapezoidal shape was created that includes the MG area to mark the eyelid borders on the tarsal conjunctival surface. The MGs that not visualized on meibography were indicated as “MG loss.” Loss rates and meiboscores of MGs were scored automatically in the device software according to the specified intervals: 0–10% loss of MGs = grade 0, 10–25% loss = grade 1, 25–50% loss = grade 2, 50–75% loss = grade 3, and 75–100% loss = Grade 4. The loss of MGs and meiboscores of the upper and lower eyelid were recorded. Then, total MG loss and meiboscore were calculated.

In the study, meiboscore was considered as ≥1 mild, ≥2 moderate, ≥3 severe, and ≥4 very severe MG loss.

The MG structure and abnormalities were examined: plugged MG orifices, MG distortion, MG thickening, MG thinning, and lid margin vascular engorgement. Each MG abnormality was counted as 1 point. Total scores were compared between the two groups.

Specular microscopy (NSP-9900, Konan, Japan) was used to examine the corneal endothelium. At least 100 adjacent cells in the center of the cornea were imaged, and endothelial cell density (ECD) (cell/mm²), coefficient of variation in cell size (CV), and percentage of hexagonal cells (PHEX) were analyzed. If the image was not sufficient for analysis, the measurements were repeated, and the clearest image was evaluated.

Correlations between the plasma levels of hormones and ocular parameters of the cases with PCOS were statistically evaluated.

**Statistical evaluation**

Statistical analyses were performed using IBM SPSS Statistics 23.0 (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.). The results are presented as mean ± standard deviation or median (minimum-maximum) for continuous variables. Categorical variables were described as frequency and percentage. The data were examined by the Shapiro–Wilk test to determine whether it presents normal distribution. Normally distributed data were compared with independent samples t-test. Normality distributed independent variables not suitable for a t-test were compared using the Mann–Whitney U test. Categorical variables were compared using Pearson’s Chi-square and Fisher’s exact test between groups. Correlations were assessed using Spearman’s rho test. The statistically acceptable significance level was P < 0.05. In order to determine the number of patients to be included in the study, a pilot study was conducted on eight patients in each group. As a result of the pilot study, the effect size for MG loss measurements in PCOS and control groups was 0.72. As a result, it was decided to include at least 32 patients in each group for 80% power and 5% significance level, with an effect size of 0.72.

**Results**

The mean age was 23.72 ± 4.46 years for the cases with PCOS and was 25.18 ± 3.57 years for the control group (P = 0.155). The IOP, SE, Schirmer’s test, and OSDI scores were summarized in Table 1. The IOP and OSDI scores were significantly different between the two groups, but IOP was within normal limits in both groups. Schirmer’s test results were not different between groups (P = 0.879).

A comparison of the corneal topographic and anterior chamber parameters, NITBUT, and corneal endothelial cell
analysis between groups appears in Table 2. The front Km, back Km, and Kmax values were steeper in cases with PCOS than healthy controls (P = 0.020, P = 0.004, and P = 0.045, respectively). There were insignificant differences in the mean values of TCT (P = 0.544), ACT (P = 0.803), and CCT (P = 0.391) between groups. The first NITBUT, average NITBUT, CV, and PHEX values were similar between cases with PCOS and control groups (P > 0.05, for all). The ECD values were lower in the PCOS group than in the healthy controls, but the difference was not statistically significant (P = 0.144).

The mean MG loss values of upper eyelids were 15.05 ± 6.87 and 10.43 ± 5.65% in cases with PCOS and control groups, respectively (P = 0.004). The mean MG loss of lower eyelids was 14.02 ± 7.9 and 8.86 ± 6.78% cases with PCOS and control groups, respectively (P < 0.001). Meiboscores of the upper eyelid were higher in PCOS cases, although there was no significant difference (P = 0.052). The lower eyelid meiboscores, total MG loss of all eyelids, and total meiboscores were significantly higher in PCOS cases compared to the control group (P = 0.005, P < 0.001, P = 0.004, respectively). In the PCOS group, 92.1% of patients had mild MG loss (total meiboscore ≥1) and 13.2% of patients had severe MG loss (total meiboscore ≥3). In the healthy control group, 71% of patients had mild MG loss (total meiboscore ≥1) and 3.2% of patients had severe MG loss (total meiboscore ≥3). The MG analysis by meibography between groups is summarized in Table 3.

When MG morphologies were examined between the two groups, degree of plugged MG orifices, MG distortion, and MG thickening were significantly higher in cases with PCOS than in control groups (P < 0.001, P = 0.022, and P < 0.001, respectively) [Figs. 1 and 2]. The degrees of lid margin vascular engorgement and MG thinning were not significantly different between the two groups. The morphology analysis of MGs between groups is summarized in Table 4.

Correlations between the plasma levels of hormones and ocular parameters of the cases with PCOS are summarized in Table 5. There was a strong correlation between plasma AMH/MIS level and Kmax value (P = 0.007, r = 0.893). There was a poor correlation between AMH/MIS level and Back Km and PHEX. There were poor correlations between E2 and PHEX and between IOP and PRG; there were negative poor correlations between E2 and total MG loss and CV; between TT and ACT; between cholesterol and upper meiboscore and ECD; and between OSDI and total meiboscore.

Discussion

Studies have shown that PCOS patients have an increased goblet cell number and MUC5AC mRNA expression and an altered meibomian secretion.[12-14] Regulation of production and secretion of meibum by the MGs is influenced by hormonal, neural, and mechanical factors.[15] Sex steroid receptors for androgens and estrogens have been identified on the MGs that may have an influence on the synthesis of meibum.[16]

The International Workshop on Meibomian Gland Dysfunction defines MGD as a chronic diffuse abnormality of the MGs, commonly characterized by terminal duct obstruction or qualitative/quantitative changes in glandular secretion.[17] Nonobvious MGD may be associated with significant MG loss and structural changes. Therefore, in patients with hormonal disorders known to affect MG function, meibography may show early MG abnormalities even if the patient is asymptomatic.[18] It has also been shown that patients with MG loss may have an increase in severe dry eye symptoms.[19] In the current study, MG loss and meiboscores of both lids were found to be significantly higher in PCOS patients compared to the control group. Consistent with our study in recent studies, the mean MG loss values were significantly higher in the PCOS group than in the control group.[10,11] In the current study, degree of

### Table 1: Demographic features of subjects

|                | PCOS n=40 | Control n=32 | P  |
|----------------|-----------|--------------|----|
| Age            | 23.72±4.46| 25.18±3.57   | 0.155 |
| IOP            | 16.52±2.81| 14.53±2.24   | 0.002 |
| SE             | -0.21±0.72| -0.10±0.71   | 0.560 |
| Schirmer’s test| 23.17±10.27| 23.80±9.18   | 0.879 |
| OSDI           | 23.71±18.57| 12.12±9.77   | 0.007 |

PCOS: polycystic ovary syndrome; HC: healthy control; IOP: intraocular pressure; SE: spherical equivalent; OSDI: ocular surface disease index. Values are presented as mean±SD (standard deviation). *Mann–Whitney test

### Table 2: Ocular parameters of the cases with PCOS and control group

|                | PCOS n=40 | Control n=32 | P  |
|----------------|-----------|--------------|----|
| Front Km       | 44.24±1.40| 43.49±1.18   | 0.020 |
| Back Km        | 6.33±0.24 | 6.2±0.23     | 0.004 |
| Kmax           | 45.74±1.61| 44.99±1.4    | 0.045 |
| TCT            | 533.89±46.26| 527.5±38.67 | 0.544 |
| ACT            | 553.73±46.69| 556.43±40.62| 0.803 |
| CCT            | 541.17±43.84| 534.2±39.24 | 0.391 |
| First NITBUT   | 12.46±5.47| 11.4±8.46    | 0.514 |
| Avg NITBUT     | 13.76±4.03| 12.5±4.13   | 0.295 |
| ECD (cell/mm²) | 2800.66±248.05| 3443.93±389.77| 0.144 |
| CV             | 45.64±6.61| 46.5±7.15    | 0.601 |
| PHEX (%)       | 44.23±7.95| 44.21±8.36   | 0.995 |

PCOS: polycystic ovary syndrome; Km: mean keratometry; Kmax: maximal keratometry; TCT: thinnest corneal thickness; ACT: apical corneal thickness; CCT: central corneal thickness; NITBUT: noninvasive tear break-up time; Avg: average; ECD: endothelial cell density; CV: coefficient of variation; PHEX: percentage of hexagonal cells; PACHY: corneal pachymetry by specular microscopy. Values are presented as mean±SD (standard deviation). *Test, *Mann–Whitney test

### Table 3: Meibomian gland analysis by meibography between groups

|                | PCOS n=40 | Control n=32 | P  |
|----------------|-----------|--------------|----|
| UPPER MG LOSS  | 15.05±6.87| 10.43±5.65   | 0.004 |
| UPPER MEIBOSCORE| 0.81±0.56| 0.54±0.56    | 0.052 |
| LOWER MG LOSS  | 14.02±7.9 | 8.86±6.78    | <0.001 |
| LOWER MEIBOSCORE| 0.72±0.64| 0.32±0.54    | 0.005 |
| TOTAL MG LOSS  | 28.85±10.46| 19.35±11.47 | <0.001 |
| TOTAL MEIBOSCORE| 1.55±0.89| 0.96±0.87    | 0.004 |

MG: meibomian gland; PCOS: polycystic ovary syndrome. Values are presented as mean±SD (standard deviation). *Test, *Mann–Whitney test
 plugged MG orifices, MG distortion, and MG thickening were significantly higher in cases with PCOS than in control groups.

A recent study reported that the composition of fatty acid changes during the menstrual cycle. The MG orifice diameter and meibometry value decreased in the latter half of the luteal phase until menstruation. This change would lead to MGD and/or meibomitis in young women. These changes are temporary in the menstrual cycle, but in women with PCOS, the effects of MG may become permanent and more severe due to hormonal disturbance. New algorithms have been proposed for the management of MGD based on noninvasive meibography. A recent study has suggested that on the basis of meiboscore, the most appropriate treatment can be selected for each MGD patient. The most commonly associated complaints of hyperandrogenism among women with PCOS are hirsutism, acne, and alopecia; treated with combined oral contraceptive agents and topical therapies. In PCOS patients with MG loss and associated dry eye symptoms, it can be predicted that systemic therapy, as well as local treatments, can be effective in the correction of MGD. The progression of MG disorder can be slowed or stopped with PCOS treatment before the symptoms of dry eye appear. Comprehensive research is needed on this subject.

Conflicting results were observed regarding TBUT values in similar studies. Consistent with most previous studies, the PCOS group in the current study showed significantly higher OSDI scores, and similar Schirmer’s test results compared to the control group. The fact that NITBUT...
Table 5: Correlation between the plasma levels of hormones and ocular parameters of the cases with PCOS

| E2    | t. Test | AMH/MIS | PRG  | Cholesterol | OSDI |
|-------|---------|---------|------|-------------|------|
| IOP   |         |         |      |             |      |
| Kmax  | 0.893** | 0.007   |      |             |      |
| Back Km | 0.786* | 0.036   |      |             |      |
| Upper M. score | -0.420* | 0.019   |      | -0.459* | 0.018 |
| Total M. score |      |         |      | -0.324* | 0.047 |
| Total MG Loss |      |         |      | -0.467* | 0.022 |
| ACT   |         | -0.467* | 0.022 |             |      |
| ECD   |         | 0.420*  | 0.017 | 0.811*      | 0.027 |
| CV    | -0.397* | 0.024   |      |             |      |
| PHEX  |         |         |      |             |      |

only significant correlations shown: E2: Estriol; t: test; total testosterone; AMH/MIS: anti-Müllerian hormone/Müllerian inhibiting substance; PRG: 17 hydroxyprogesterone; IOP: intraocular pressure; OSDI: ocular surface disease Index; Kmax: maximal keratometry; Km: mean keratometry; ACT: apical corneal thickness; MG: meibomian gland; M. score: meiboscore; ECD: endothelial cell density; CV: coefficient of variation; PHEX: percentage of hexagonal cells.

Spearman test was used for correlation analysis. P value below 0.05 was considered significant. *There is poor correlation. **There is strong correlation.

does not decrease despite the loss of MG may be due to the increased lipid production capacity of the remaining glands by compensatory mechanisms. MG distortion and thickening may also be the result of this compensatory mechanism.

In the PCOS cases, a weak negative correlation was detected between the serum E2 level and total MG loss and between the OSDI score and total meiboscore. Consistent with current study, in the study of Baser et al., no correlation was found between the testosterone levels and the hormonal balances change affecting the eye tissues. In the lacrimal and MGs, a number of identical genes were influenced by testosterone, E2, and/or PRG. The nature of the gene response to these hormones was sometimes similar but often opposite. Both hormones antagonize each other’s regulation of their own receptor, in sebaceous glands. In the current study, a negative correlation between the serum E2 level and total MG loss suggests that E2 is effective in MGD in PCOS patients. However, the fact that there was no significant difference in tear parameters in the PCOS group compared to the control group despite the significant decrease in MG maybe due to the dose-dependent antagonistic effects of sex hormones. It is also possible that as a result of long-term exposure to androgen, insensitivity and/or downregulation in androgen receptors may occur, and this may be a factor that reduces tear production. When PCOS progresses, the development of MGD might be more severe.

Estrogen, progesterone, and androgen receptors have been identified in the nuclei of human corneal epithelial, stromal, and endothelial cells. Studies have shown that corneal thickness, curvature, and sensitivity change depending on hormonal changes at different times of the menstrual cycle. The current study also examined corneal thickness and curvature change. Inconsistent with previous studies there were insignificant differences in the mean values of TCT, ACT, and CCT between groups. However, there was a weak negative correlation between TT and ACT suggests that corneal thickness may be affected in cases with higher testosterone levels. In previous studies, CCT measurements were greater in patients with PCOS and those are correlated with serum testosterone and estradiol levels. Increased corneal thickness was associated with insulin resistance and higher insulin-like growth factor-1 (IGF-1) levels in PCOS. The lack of significant difference between the two groups in this study may be due to the fact that the PCOS group did not have enough insulin resistance to affect the corneal thickness.

In recent years, CCT has been suggested to be a risk factor for glaucoma. Increased IOP in PCOS patients has been associated with CCT in previous studies. However, in the current study, although corneal thickness was similar between the two groups, IOP was higher in the PCOS group. The correlation between IOP and PRG, although poor, suggests that other factors, which we do not know, may also be effective in the increase in IOP. Studies show conflicting results in the relationship between testosterone and IOP. More extensive studies are needed to evaluate IOP in PCOS patients.

In recent years, the effects of sex hormones on corneal biomechanics have been studied. Estrogens are responsible for weakening the cornea via the stimulation of matrix metalloproteinases and the release of prostaglandins, causing activation of proteolytic enzymes for collagen, disruption of collagen, and reduction in corneal stiffness. Recently, there has been evidence that exogenous DHEA may contribute to keratoconus (KC) development or progression by reducing localized production of IGF-1 and autocrine or paracrine signaling contributing to altered metabolic function. The role of sex hormones in causing changes in the cornea during pregnancy has long been documented, as hormonal fluctuations result in corneal alterations including increases in corneal volume, CCT, and curvature. In agreement with an increased occurrence of post-LASIK corneal ectasia, multiple studies have found KC progression or onset to be influenced by pregnancy. Studies have reported significant changes in androgens and estrogens in KC patients compared to healthy subjects. It has been shown that topically applied 17β-estradiol reduces corneal stiffness and showed a reversible myopic shift. Recent studies show that the human cornea is a hormone-sensitive tissue that is significantly affected by E1
and E3, and that sex hormone receptors are involved in the pathobiology of KC. A recent study has expanded the list of organs known to express gonadotropins or their receptors to include the human cornea, demonstrating the role of LH/FSH in the pathophysiology of KC. These findings suggested that the human cornea is capable of responding to gonadotropins and propose an intriguing mechanism for the onset and/or progression of KC. Thus, the human cornea was first described as an extragonadal tissue. In the current study, the front Km, back Km, and Kmax values were steeper in cases with PCOS than healthy controls. These results support previous studies and show that changes in sex hormones may cause corneal curvature changes in PCOS patients, similar to pregnancy. Considering the prevalence of PCOS in young women, we believe that patients should be followed carefully for the development of corneal ectasia. Early diagnosis and treatment of KC patients with PCOS may alter the progression or stability of KC. In addition, by screening for PCOS in female KC patients, the progression of corneal ectasia can be stopped by treating the existing hormone disorder.

In this study, CV and PHEX values were similar between cases with PCOS and control groups. The ECD values were lower in the PCOS group but not statistically significant. However, the presence of a poor correlation between E2 and AMH levels and corneal endothelial parameters suggests that there may be a change in specular microscopy findings when the severity of the disease increases. There are a limited number of studies on the effects of sex hormones on the corneal endothelium. The structure of endothelial cells in PCOS patients has not been investigated extensively yet. In a study evaluating the anterior segment in a pediatric population with hypogonadism, ECD values were found to be significantly lower in the group receiving hormone replacement therapy than in the group receiving no treatment. In a study investigating the E1 and E3 response in corneal stromal cells from healthy and Keratoconus donors, sex hormone receptors were also found in the nuclei of corneal epithelial and endothelial cells. This finding shows that sex hormones also affect the endothelium in keratoconus. Studies have shown that as the tomographic severity of keratoconus increases, ECD decreases, and CV increases significantly. In PCOS patients, both the corneal stroma and the endothelium may be affected by sex hormones and keratoconus may develop. More detailed research is required for this.

MIS, also known as AMH, is a polypeptide of the transforming growth factor beta family, secreted by the granulosa cells of small antral and preantral follicles to regulate early follicular development. Overall, serum AMH levels are significantly higher in women with PCOS compared with normal ovulatory women. Serum AMH could be a valuable surrogate marker for overall diagnosis of PCOS or an alternative to ultrasound count. In recent years, it has been suggested to integrate both the U/S data and the serum AMH level to define the polycystic ovary in the Rotterdam classification. In the current study, the relationship between AMH levels and the data of PCOS patients was examined. Interestingly, there was a correlation between AMH and keratometry values (Kmax and back Km) and PHEX levels. This finding suggests that as the number of cysts increases in PCOS, the cornea may be more affected, the risk of keratoconus may increase, and AMH may be considered as a biomarker in these patients.

The limitations of our study are the relatively small number of patients and disease duration and severity of PCOS patients were not evaluated. In addition, only the findings of PCOS patients were correlated with hormone levels.

**Conclusion**

As a result of this study, loss and morphological deterioration of the MGs are observed in PCOS patients, even if the tear parameters are not impaired yet. In eyes with PCOS, keratometry values become steeper in proportion to AMH levels, and the risk of keratoconus may increase. Therefore, follow-up can be recommended for the development of corneal ectasia. The corneal endothelium and corneal thickness may not be affected in the early stages. However, they may be affected as the disease progresses and sex hormones increase. We suggest that the relationship between the severity, duration, and hormone levels of PCOS disease and corneal structure, IOP, and dry eye parameters be evaluated with more comprehensive studies.

**Data availability statement**

The data that support the findings of this study are available from the corresponding author [ATB], upon reasonable request.

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**Conflicts of interest**

There are no conflicts of interest.

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