International Journal of Medical Ophthalmology

E-ISSN: 2663-8274
P-ISSN: 2663-8266
www.ophthalmoljournal.com
IJMO 2021; 3(1): 33-40
Received: 17-11-2020
Accepted: 25-12-2020

Sampoorna H Rao
Department of Ophthalmology, Vydehi Institute of Medical Sciences and Research Centre, Bangalore, Karnataka, India

Alhaj Farhath Tasneem
Department of Ophthalmology, Vydehi Institute of Medical Sciences and Research Centre, Bangalore, Karnataka, India

Vittal I Nayak
Department of Ophthalmology, Vydehi Institute of Medical Sciences and Research Centre, Bangalore, Karnataka, India

Faiza Syed Jafar
Department of Ophthalmology, Vydehi Institute of Medical Sciences and Research Centre, Bangalore, Karnataka, India

Sara Nastain
Department of Ophthalmology, Vydehi Institute of Medical Sciences and Research Centre, Bangalore, Karnataka, India

Yalavali Indraja
Department of Ophthalmology, Vydehi Institute of Medical Sciences and Research Centre, Bangalore, Karnataka, India

Corresponding Author:
Sampoorna H Rao
Department of Ophthalmology, Vydehi Institute of Medical Sciences and Research Centre, Bangalore, Karnataka, India

Evaluation of central corneal thickness with meibomian gland dysfunction in postmenopausal women

Sampoorna H Rao, Alhaj Farhath Tasneem, Vittal I Nayak, Faiza Syed Jafar, Sara Nastain and Yalavali Indraja

DOI: https://doi.org/10.33545/26638266.2021.v3.i1a.59

Abstract
Background: Meibomian gland dysfunction is a common chronic disease of eyelid wherein there is reduction in the quantity as well as changes in the composition of meibomian gland secretions, resulting in instability and thinning of the tear film which ultimately interferes with the ocular surface. It has also been observed that postmenopausal women may present with decrease in central corneal thickness due to hormonal changes. Studies have been done regarding the role of meibomian gland dysfunction in central corneal thickness changes.
Objectives: To assess and compare the central corneal thickness and estimate estradiol levels in postmenopausal women with and without MGD, as well as and to correlate estradiol levels with severity of MGD in postmenopausal women with MGD.
Design: Duration based, comparative two-group study.
Participants: 80 participants with 160 eyes among which 40 were postmenopausal women with MGD and 40 were postmenopausal women without MGD.
Methods: All female subjects satisfying the inclusion and exclusion criteria in the age group of 52 – 65 years who visited VIMS and RC, Bangalore between January 2018 to February 2020 were included. They underwent full ophthalmological examination – visual acuity assessment, retinoscopy, refraction, slit lamp examination, fundus examination, horizontal and vertical corneal curvature assessment, specular microscopy, tear break up time and Schirmer I test along with estimation of estrogen, progesterone and FSH levels.
Results: This study concluded that mean central corneal thickness was reduced in case of postmenopausal women with MGD when compared to postmenopausal women without MGD with statistically significant results.
Conclusion: Central corneal thickness was considerably less in postmenopausal women with MGD when compared to postmenopausal women without MGD, CCT assessment must be considered in every woman, especially in elderly patients.

Keywords: Central corneal thickness, meibomian gland dysfunction, postmenopausal women, specular microscopy

1. Introduction

Menopause is defined as permanent cessation of menses. By convention the diagnosis of menopause is not made until the individual has had 12 months of amenorrhoea [1]. It plays an important role in the development of ocular surface dryness symptoms and there is increased prevalence of dry eye in women, especially those aged over 50. Despite the high prevalence of dry eye in post-menopausal women (PMW), very few studies have been undertaken to understand dry eye disease in a group of PMW who are not on Hormone Replacement Therapy (HRT).

By WHO the term postmenopause is defined as dating from the final menstrual period, regardless whether the menopause was induced or spontaneous. The postmenopause lasts about 10–15 years and is followed by the senescence from about 65 years of age to the end of life. This age limit is marked by the successive occurrence of the maximum rate of cardiovascular, orthopaedic, Ophthalmological and oncologic diseases. After this age, oestrogen substitution may be accompanied by higher vascular and oncologic risks [1]. Various Ophthalmological changes occurs in postmenopausal women one of which is Dry eye with meibomian gland dysfunction.

Meibomian gland dysfunction (MGD) is chronic, diffuse abnormality of the meibomian glands, commonly characterized by terminal duct obstruction and/or qualitative/quantitative

changes in the glandular secretion resulting in alteration of the tear film, symptoms of eye irritation, clinically apparent inflammation, and ocular surface disease and the prevalence is 38.9% in apparently normal patients but in women over 60 years of age, prevalence increases to nearly 68% [2]. The role of inflammation in the etiology of MGD is controversial and uncertain [3].

Subjective symptoms of eye irritation are included in the definition, as it is the symptoms that are of greatest concern to the patient and often to the clinician. Improvement in the patient's symptoms is the major goal in the treatment of MGD [3].

Recent literature has used terms posterior blepharitis and MGD as synonymous, but these terms are not interchangeable. Posterior blepharitis describes inflammatory conditions of posterior lid margin, of which MGD is only one possible cause. In the earliest stages, MGD may not be associated with clinical signs characteristic of posterior blepharitis. At this stage, affected individuals may be symptomatic, or, they may be asymptomatic and the condition regarded as subclinical. As MGD progresses, symptoms develop and lid margin signs like changes in meibum expressibility and quality and lid margin redness, may become more visible and MGD-related posterior blepharitis is said to be present [3].

Meibomian gland disease is used to describe a broader range of meibomian gland disorders, including neoplasia and congenital disease. Other terms such as meibomitis describe a subset of disorders of MGD associated with inflammation of the meibomian glands. Although inflammation may be important in the classification and in the therapy of MGD, these terms are not sufficiently general, as inflammation is not always present [3].

MGD may be classified according to anatomic changes, pathophysiological changes or the severity of disease but a classification based on pathophysiology is deemed to be the best, hence we have classified MGD into two major categories: low-delivery states and high-delivery states. Low-delivery states are further classified as hyposecretory or obstructive with cicatricial and non-cicatricial subcategories. Hyposecretory MGD describes condition of decreased meibum delivery due to abnormalities in meibomian glands without remarkable obstruction. Obstructive MGD is due to the terminal duct obstruction. In the cicatricial form, the duct orifices are dragged posteriorly into the mucosa, whereas duct orifices remain in their normal positions in non-cicatricial MGD. High-delivery hypersecretory MGD is characterized by release of a large volume of lipid at the lid margin that becomes visible on application of pressure onto the tarsus during examination. Each MGD category also has primary causes, referring to conditions for which there are no discernible underlying causes or etiology. Overall, MGD can lead to alterations of the tear film, symptoms of eye irritation, inflammation and dry eye [3].

The importance of meibomian gland function has been emphasized because lipids secreted by these glands combine with the outer layers of the tear film to suppress evaporation of tear fluid and to prevent loss of tears. In meibomian gland dysfunction, a reduction in the quantity and changes in the composition of meibomian gland secretions result in instability and thinning of the tear film which interferes with the ocular surface [4].

A decrease in central corneal thickness in postmenopausal women due to hormonal changes has been observed. There have also been studies regarding the role of meibomian gland dysfunction contributing to changes in central corneal thickness. A study by Juan A Sanchis *et al*. concluded that postmenopausal women with dry eye have reduced central corneal thickness when compared to those without dry eye [5]. A study conducted by Ilknur Akyol Salman *et al*. showed that there was no statistically significant difference in mean central corneal thickness measurement in the meibomian gland dysfunction group in comparison with the control group ($p>0.05$) [6]. However the above study was not in postmenopausal women.

This study is being done to evaluate the possible influence of meibomian gland dysfunction on central corneal thickness in postmenopausal women so that therapeutic strategy can target a meibomian gland dysfunction dry eye.

2. Aim of the study

To assess and compare the central corneal thickness as well as to estimate estradiol levels in postmenopausal women with and without meibomian gland dysfunction. To also correlate estradiol levels with severity of meibomian gland dysfunction in postmenopausal women with meibomian gland dysfunction.

3. Materials and methods

This study was conducted on subjects of age group 35 years old and above who visited the out-patient department of Ophthalmology at Vydehi Institute of Medical Sciences and Research Center from January 2018 to February 2020. All patients were of Indian ethnicity and visited the centre voluntarily.

This was a duration-based comparative study. The study population composed of eighty participants, forty of whom were postmenopausal women with meibomian gland dysfunction and forty without meibomian gland dysfunction. All cases satisfied the inclusion and exclusion criteria.

3.1 Inclusion Criteria

Women of the age group 52-65 years with and without meibomian gland dysfunction from whom written informed consent was taken.

3.2 Exclusion Criteria

(1.) Use of hormonal replacement therapy (2.) History of eye diseases (3.) History of use of ocular medications. (4.) Known case of hypertension, diabetes, thyroid disease, mental illness and on medications for the same (5.) Those women who are not willing to participate in the study.

3.3 Investigations and Interventions

1. Best corrected visual activity: performed by same experienced certified vision examiner in the same room with standardized low light conditions using Snellen's chart at single sitting
2. Horizontal and vertical corneal curvature- was obtained using autorefractometer.
3. Slit Lamp Examination for anterior segment evaluation was done in each and every subject pre and post dilatation stage. Although direct illumination is most commonly used technique, additional pathology may be revealed by other techniques like oblique illumination, scleral scatter, retroillumination and specular reflection to rule out exclusion criteria.
4. Direct ophthalmoscopy for posterior segment evaluation
5. Specular microscopy for measuring endothelial cell density and central corneal thickness using the Model-Konan Cellcheck SL Premier Endothelial Analytics.

Konan CellChek SL quantitatively analyzes the information and generates four numeric indices: cell density (CD), coefficient of variation (CV), percentage of hexagonal cells (HEX), number of cells used to calculate the results (NUM) and pachymetry (Pach). The first three indices are useful for measuring endothelial cell death.

CD is a measurement of endothelial cell density in mm^2

CV represents the coefficient, or degree, of variation in the sizes of the endothelial cells (polymegathism). A CV less than 40 is normal.

HEX indicates the variability in hexagonal cell shape over time. A value above 50% is suggested to be normal.

Pachymetry was done using the same non-contact specular microscope. This lowered the risk of infection and corneal epithelial damage or erosion. The average of three consecutive measurements was used for statistical analysis. Mean value of normal CCT for this machine was considered to be 554.78+/-32.61 [6].

6. Tear Break Up Time was assessed by instilling one drop of 2% sodium fluorescein dye into the eye without anaesthesia. After asking the patient to blink three to four times, the tear film was observed using a biomicroscope with a cobalt-blue filter with broad illumination. The time to the first break in the tear film complex after the last eye blink was measured.
7. Schirmer 1 test was determined by placing a Schirmer strip into the temporal one-third inferior fornices. Topical anaesthesia was not applied. Results were read as the number of millimetres of wetting at five minutes.
8. Additional tests performed for this study: (i) estrogen levels (ii) progesterone levels (iii) Follicle stimulating hormone levels.

3.4 Study Design

This was a duration based, comparative study. The study population was composed of 2 case groups i.e. 40 patients who were postmenopausal women with meibomian gland dysfunction and 40 postmenopausal women without meibomian gland dysfunction. All cases satisfied the inclusion and exclusion criteria. A pre-structured proforma was used to collect the baseline data and an informed written consent was obtained after explaining about the need for the study and the procedures that were to be performed for the collection of the data. This study received ethical approval from Vydehi Institutional Ethical Committee.

3.5 Statistical Methods

Descriptive and inferential statistical analysis was done. Results on continuous measurements are presented on Mean $\pm$ SD (min-max) and results on the categorical measurements are presented in Number (%). Significance is assessed at 1 % level of significance. The following assumptions on data were made: (1) Dependent variables should be normally distributed. (2) Samples drawn from the population should be random (3) Cases of the samples should be independent.

Student t test (two tailed, independent) has been used to find significance of study parameters on continuous scale between two groups (Intergroup analysis) on metric parameters. Leven`s test for homogeneity of variance has been performed to assess the homogeneity of variance. Chi-square/Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups, non-parametric setting for qualitative data analysis. Fisher exact test used when cell samples are very small. Pearson correlation between study variables is performed to find the degree of relationship, Pearson correlation co-efficient ranging between -1 to 1, -1 being the perfect negative correlation, 0 is no correlation and 1 means perfect positive correlation. Strongly significant: p value <0.01.

The statistical softwares used in this study were mainly SPSS 22.0 and R environment ver.3.2. Microsoft word and Excel have been used to generate graphs and tables. Sample size was estimated by using the mean central corneal thickness values from the study by Sanchis-Gimenoet *et al*. [7] Sample size was calculated using following assumption - 1% alpha error, 90% power and 99% confidence limit. Sample size required per group is 37, hence rounded off to 40. Study included 40 cases and 40 controls.

4. Results

All patients in this study were between 52-65 years. Mean age of study group I was 57.85 $\pm$ 4.50 years and group II was 59.45 $\pm$ 4.78 years. The number of years since last menstrual cycle was 8.75 $\pm$ 4.60 years in group I and 9.83 $\pm$ 4.68 years in group II.

Table 1 describes TBUT distribution in the two groups. In group I, 92.5% of patients had TBUT between 6-10 seconds in right eye and 100% in left eye. In group II, 100% of patients had TBUT between 11-15 seconds in right eye and 97.5% in left eye.

Table 1: TBUT distribution in the two groups

TBUT	Group I (n=40)	Group II (n=40)	Total (n=80)	p value
Right Eye				
1-5	3 (7.5%)	0 (0%)	3 (3.8%)	0.241
6-10	37 (92.5%)	0 (0%)	37 (46.3%)	0.241
11-15	0 (0%)	40 (100%)	40 (50%)	<0.001
16-20	0 (0%)	0 (0%)	0 (0%)	1.000
Left Eye				
1-5	0 (0%)	0 (0%)	0 (0%)	1.000
6-10	40 (100%)	0 (0%)	40 (50%)	<0.001
11-15	0 (0%)	39 (97.5%)	39 (48.8%)	1.000
16-20	0 (0%)	1 (2.5%)	1 (1.3%)	1.000

Table 2 describes Schirmer's I test results in both groups. In group I, 52.5% of patients had Schirmer's test value between 6-10 seconds in right eye and 50% in left eye. In group II, 95% of patients had Schirmer's test value between 16-20 seconds in right eye and 50% in left eye.

Table 2: Schirmer's test distribution in the two groups

Schirmer's I test	Group I (n=40)	Group II (n=40)	Total (n=80)	p value
Right Eye				
1-5	1 (2.5%)	0 (0%)	1 (1.3%)	1.000
6-10	21(52.5%)	0 (0%)	21 (26.3%)	<0.001
11-15	18 (45%)	2 (5%)	20 (25%)	<0.001
16-20	0 (0%)	38 (95%)	38 (47.5%)	<0.001
Left Eye				
1-5	2 (5%)	0 (0%)	2 (2.5%)	0.494
6-10	19(47.5%)	0 (0%)	19(23.8%)	<0.001
11-15	19(47.5%)	0 (0%)	19(23.8%)	<0.001
16-20	0 (0%)	40(100%)	40 (50%)	<0.001

Table 3 and Figure 1 show the comparison of TBUT and Schirmer's I test in the two study groups with statistically significant results. The mean TBUT value of right eye was 7.48 $\pm$ 1.34 in group I and 12.40 $\pm$ 1.19 in group II. Mean TBUT value of left eye was 8.15 $\pm$ 1.17 in group I and was 12.53 $\pm$ 1.36 in group II. Mean Schirmer's value of right eye

was 9.93 ± 2.54 in group I and 16.85 ± 1.03 in group II. Mean Schirmer's value of left eye was 10.15 ± 2.81 in group I and 16.93 ± 0.89 in group II. Mean TBUT and Schirmer's values was less in group I than in group II and the difference was statistically significant (p-value < 0.001).

Table 3: Comparison of TBUT and Schirmer's I test between study groups

	Group I	Group II	Total	P value
K1				
Right Eye	44.36 ± 0.93	44.40 ± 0.88	44.38 ± 0.90	0.854
Left Eye	44.46 ± 1.00	44.48 ± 0.88	44.47 ± 0.94	0.929
K2				
Right Eye	44.39 ± 1.09	43.81 ± 3.10	44.10 ± 2.33	0.267
Left Eye	44.46 ± 1.07	44.32 ± 0.93	44.39 ± 1.00	0.541
CD(/mm^2)				
Right Eye	2654.23 ± 209.16	2563.63 ± 241.06	2608.93 ± 228.83	0.076 +
Left Eye	2661.78 ± 206.30	2591.80 ± 228.77	2626.79 ± 219.28	0.155
CV				
Right Eye	33.70 ± 6.49	40.50 ± 24.67	37.10 ± 18.24	0.096 +
Left Eye	33.08 ± 4.46	37.98 ± 15.96	35.53 ± 11.90	0.065 +
HEX (%)				
Right Eye	43.98 ± 6.43	45.83 ± 6.08	44.90 ± 6.28	0.190
Left Eye	43.98 ± 6.89	46.53 ± 5.54	45.25 ± 6.35	0.072+

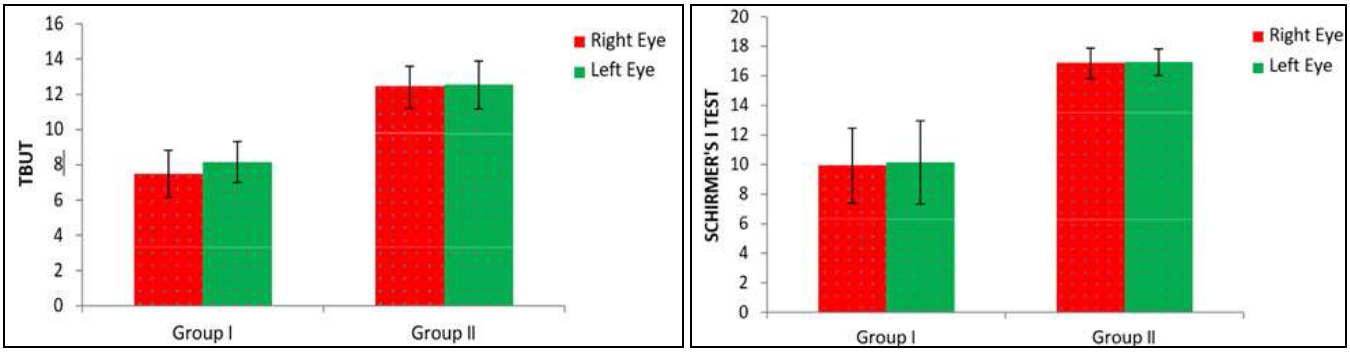

Fig 1: Comparison of TBUT and Schirmer's I test in the study groups

Table 4 depicts the comparison of K1, K2, CD, CV and HEX in the two study groups and the results were not statistically significant. The mean of K1 vertical curvature of cornea of right eye was 44.36 ± 0.93 in group I and 44.40 ± 0.88 in group II. The mean of K1 vertical curvature of cornea of left eye was 44.46 ± 1.00 in group I and 44.48 ± 0.88 in group II. The mean of K2 horizontal curvature of cornea of right eye was 44.39 ± 1.09 in group I and 43.81 ± 3.10 in group II. The mean of K2 horizontal curvature of cornea of left eye was 44.46 +/-1.07 in group I and 44.32 ± 0.93 in group II. The mean endothelial cell density of cornea of right eye was 2654.23 ± 209.16 in group I and 2563.63 ± 241.06 in group II. The mean endothelial cell density of cornea of left eye was 2661.78 ± 206.30 in group I and 2591.80 ± 228.77 in group II.

The mean coefficient of variation of endothelial cells of cornea of right eye was 33.70 ± 6.49 in group I and 40.50 ± 24.67 in group II. The mean coefficient of variation of endothelial cells of cornea of left eye was 33.08 ± 4.46 in group I and 37.98 ± 15.96 in group II. The mean percentage of hexagonal cells of cornea of right eye was 43.98 ± 6.43 in group I and 45.83 ± 6.08 in group II. The mean percentage of hexagonal cells of cornea of left eye was 43.98 ± 6.89 in group I and 46.53 ± 5.54 in group II. The mean of K1 of right and left eye was more in group II than group I, whereas mean of K 2 of right and left eye was more in group I than group II. Mean endothelial cell density was more in group I, whereas mean coefficient of variation of endothelial cells and percentage of hexagonal cells of cornea was found more in group II. However, results were not statistically significant.

Table 4: Comparison of K1, K2, CD, CV and HEX between the study groups

	Group I	Group II	Total	P value
TBUT				
Right Eye	7.48±1.34	12.40±1.19	9.94±2.78	<0.001
Left Eye	8.15±1.17	12.53±1.36	10.34±2.54	<0.001
Schirmer's I Test				
Right Eye	9.93±2.54	16.85±1.03	13.39±3.98	<0.001
Left Eye	10.15±2.81	16.93±0.89	13.54±3.99	<0.001

Table 5 depicts the comparison of NUM, PACH (central corneal thickness), FSH, estrogen and progesterone in the two study groups and was not statistically significant except for FSH. The mean number of cells used for calculation for right eye was 140.18 ±15.27 in group I and 135.20 ± 21.72 in group II. The mean number of cells used for calculation for left eye was 141.78 ± 13.80 in group I and 140.23 ± 12.98 in group II. The mean central corneal thickness of right eye was 529.33 ± 32.64 in group I and 553.98 ± 43.41 in group II. The mean central corneal thickness of left eye was 525.10 ± 40.21 in group I and 550.58 ± 40.04 in group II. The mean FSH was 44.96 ± 23.32 in group I and 71.72 ± 33.62 in group II. The mean estrogen was 20.43 ± 7.53 in group I and 22.38 ± 13.91 in group II. The mean progesterone was 0.29 ± 0.24 in group I and 0.30 ± 0.36 in group II. The tests for PACH and FSH were found to be significant. FSH values were lower in group I than in group II. Estrogen and progesterone levels were found higher in group II but not statistically significant.

Table 5: Comparison of NUM, PACH, FSH, estrogen and progesterone between the two groups

Variables	Group I	Group II	Total	P value
NUM (cells)				
Right Eye	140.18 ± 15.27	135.20 ± 21.72	137.69 ± 18.82	0.240
Left Eye	141.78 ± 13.80	140.23 ± 12.98	141.00 ± 13.34	0.606
PACH (um)				
Right Eye	529.33 ± 32.64	553.98 ± 43.41	541.65 ± 40.13	0.005
Left Eye	525.10 ± 40.21	550.58 ± 40.04	537.84 ± 41.88	0.006
FSH (miu/mL)	44.96 ± 23.32	71.72 ± 33.62	58.34 ± 31.75	<0.001
Estrogen (pg/mL)	20.43 ± 7.53	22.38 ± 13.91	21.40 ± 11.15	0.438
Progesterone (ng/mL)	0.29 ± 0.24	0.30 ± 0.36	0.30 ± 0.31	0.845

Table 6 and Figure 2 depicts the central corneal thickness distribution of patients in the two groups. Most patients in group I had CCT between 521-530 and those in group II had CCT between 541-550. The mean central corneal thickness was found to be thinner in group I than group II and this was statistically significant.

Table 6: CCT distribution among the two groups

CCT	Group I	Group II	Total
440-450	1(1.3%)	0(0%)	1(0.6%)
451-460	1(1.3%)	1(1.3%)	2(1.3%)
461-470	1(1.3%)	0(0%)	1(0.6%)
471-480	5(6.3%)	3(3.8%)	8(5%)
481-490	7(8.8%)	2(2.5%)	9(5.6%)
491-500	5(6.3%)	4(5%)	9(5.6%)
500-510	7(8.8%)	4(5%)	11(6.9%)
511-520	9(11.3%)	9(11.3%)	18(11.3%)
521-530	11(13.8%)	2(2.5%)	13(8.1%)
531-540	7(8.8%)	5(6.3%)	12(7.5%)
541-550	4(5%)	12(15%)	16(10%)
551-560	5(6.3%)	4(5%)	9(5.6%)
561-570	6(7.5%)	8(10%)	14(8.8%)
571-580	4(5%)	5(6.3%)	9(5.6%)
581-590	2(2.5%)	3(3.8%)	5(3.1%)
591-600	4(5%)	5(6.3%)	9(5.6%)
601-610	1(1.3%)	6(7.5%)	7(4.4%)
611-620	0(0%)	5(6.3%)	5(3.1%)
621-630	0(0%)	2(2.5%)	2(1.3%)
Total	80(100%)	80(100%)	160(100%)

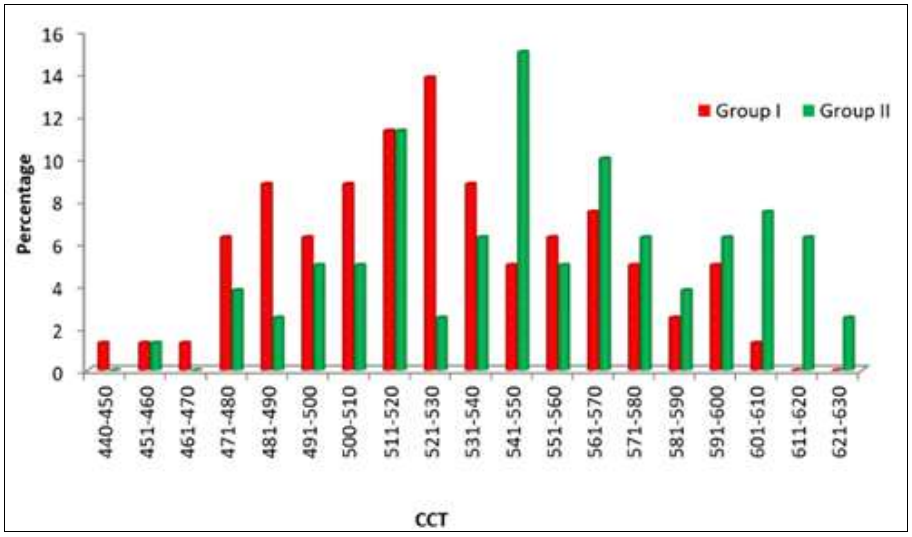

Fig 2: CCT distribution among the two groups

Table 7 shows the comparison of clinical variables of patients in both groups. TBUT, Schirmer I test and CCT were statistically significant. K1, K2, Estrogen and Progesterone tests were not statistically significant. TBUT, Schirmer's 1 test, K1, CCT, Estrogen and Progesterone are lower in group I than in group II, whereas K2 is low in group II.

Table 7: Comparison of clinical variables between the two groups

Variables	Group I	Group II	Total	P value
TBUT	7.81 ± 1.29	12.46 ± 1.27	10.14 ± 2.66	<0.001
Schirmers I	10.04 ± 2.66	16.89 ± 0.95	13.46 ± 3.97	<0.001
K1	44.41 ± 0.96	44.44 ± 0.88	44.43 ± 0.92	0.847
K2	44.43 ± 1.08	44.07 ± 2.29	44.25 ± 1.79	0.206
CCT	527.21 ± 36.45	552.28 ± 41.53	539.74 ± 40.93	<0.001
Estrogen	20.43 ± 7.48	22.38 ± 13.82	21.40 ± 11.12	0.269
Progesterone	0.29 ± 0.24	0.30 ± 0.36	0.30 ± 0.30	0.780

Table 8 shows the degree of correlation between TBUT and K1, TBUT and K2, TBUT and CCT. In group I TBUT is negatively correlated to K1 and CCT i.e., if TBUT value increases K1 and CCT decreases. Similarly, TBUT is positively correlated to K2. In group II, TBUT is positively correlated to K1, K2 and CCT. However, these correlations are not statistically significant.

Table 8: Pearson correlation between TBUT and K1, K2, CCT in the study groups

Variables	Group I		Group II	
	r value	p value	r value	p value
TBUT vs K1	-0.044	0.699	0.036	0.749
TBUT vs K2	0.028	0.802	0.046	0.686
TBUT vs CCT	-0.093	0.414	0.068	0.548

Table 9 shows the degree of correlation between Schirmer's I test and K1, Schirmer's I test and K2, Schirmer's I test and CCT. In group I Schirmer's 1 test is positively correlated to K1, K2 and CCT. In group II Schirmer's I test is positively correlated to K1 and CCT and negatively correlated to K2. However, Schirmer's I test correlations are not statistically significant with K1 and K2 but are significant with CCT.

Table 9: Pearson correlation between Schirmer's test I and K1, K2 and CCT

Variables	Group I		Group II	
	r value	p value	r value	p value
Schirmers I vs K1	0.243	0.030	0.170	0.132
Schirmers I vs K2	0.210	0.061+	- 0.089	0.431
Schirmers I vs CCT	0.296	0.008	0.462	< 0.001

Table 10 shows the degree of correlation between estrogen and K1, estrogen and K2, estrogen and CCT. In group I, estrogen is positively correlated to K1 and negatively correlated to K2 and CCT. In group II, estrogen is positively correlated to K1 and K2 and negatively correlated to CCT. However, these correlations are not statistically significant.

Table 10: Pearson correlation between estrogen and K1, K2 and CCT

Variables	Group I		Group II	
	r value	p value	r value	p value
Estrogen vs K1	0.050	0.659	0.008	0.947
Estrogen vs K2	-0.112	0.321	0.040	0.725
Estrogen vs CCT	-0.075	0.507	-0.160	0.156

Table 11 shows the degree of correlation between progesterone and K1, progesterone and K2, progesterone and CCT. In group I, progesterone is positively correlated to K1 and K2 and negatively correlated to CCT. In group II, progesterone is positively correlated to K1, K2 and CCT. However, these correlations are not statistically significant.

Table 11: Pearson correlation between progesterone and K1, K2 and CCT

Variables	Group I		Group II	
	r value	p value	r value	p value
Progesterone vs K1	0.022	0.846	0.006	0.961
Progesterone vs K2	0.055	0.627	0.016	0.891
Progesterone vs CCT	-0.025	0.825	0.035	0.761

Table 12 shows the degree of correlation of estrogen with TBUT, Schirmer's test and progesterone with TBUT, Schirmer's I test. In group I, estrogen is positively correlated to TBUT and Schirmer's I test. In group II, estrogen is positively correlated to TBUT and negatively correlated to Schirmer's I test. In group I, progesterone is negatively correlated to TBUT and Schirmer's test. In group II, progesterone is positively correlated to TBUT and negatively correlated to Schirmer's test. However, these correlations are not statistically significant.

Table 12: Pearson correlation between estrogen and TBUT and Schirmer's I test along with Pearson correlation between progesterone and TBUT and Schirmer's test I

Variables	Group I		Group II	
	r value	p value	r value	p value
Estrogen vs TBUT	0.044	0.701	0.059	0.602
Estrogen vs Schirmer's test	0.057	0.615	-0.179	0.112
Progesterone vs TBUT	-0.025	0.823	0.044	0.700
Progesterone vs Schirmer's test	-0.131	0.245	-0.104	0.360

Table 13 shows the degree of correlation of FSH with TBUT, Schirmer's test. In group I FSH is positively correlated to TBUT and negatively correlated to Schirmer's 1 test. In group II, FSH is positively correlated to TBUT and Schirmer's test. However, these correlations are not statistically significant.

Table 13: Pearson correlation between FSH and TBUT and Schirmer's test

Variables	Group I		Group II	
	r value	p value	r value	p value
FSH vs TBUT	0.311	0.051	0.117	0.472
FSH vs Schirmers test	-0.051	0.755	0.047	0.775

5. Discussion

Our study aimed at evaluating central corneal thickness in postmenopausal women with meibomian gland dysfunction. To the best of our knowledge, extensive studies have not been done in this field.

Prevalence of dry eye increases with age. In our study, TBUT and Schirmer's 1 test was used to assess dryness in the study groups. As we have seen in Table 3, mean TBUT and Schirmer's I values was less in group I than in group II and the difference was statistically significant (P-value <0.001). These findings are consistent with a study done by Salman AI *et al.* in which mean Schirmer I values were 10.38 $\pm$ 5.84 mm in the MGD group and 20.35 $\pm$ 6.12 mm in the control group (p<0.05) [5]. The mean tear break-up

time values were 9.43 ± 6.18 seconds in the meibomian gland dysfunction group and 18.05 ± 4.31 seconds in the control group ($p < 0.05$).

On analyzing the keratometry findings in our study groups as is shown in Table 4, the mean of K1 of right and left eye was more in group II than in group I whereas mean of K2 of right and left eye was more in group I than in group II.

A randomized prospective study conducted to assess the effect of menopause on the corneal curvature changes using corneal computerized video keratography (CVK) in premenopausal and postmenopausal healthy women by Aydin E *et al* showed mean horizontal curvature and vertical curvature of central corneal power in premenopausal women were 43.5 ± 1.25 Dioptre (D), and 44.1 ± 1.53 D [6]. Mean horizontal curvature and vertical curvature of central corneal power in postmenopausal women were 43.9 ± 1.4 D and 44.6 ± 1.3 D. The mean keratometric astigmatisms of premenopausal and postmenopausal women were 0.81 ± 0.57 D (4–179 degrees), 0.74 degrees ± 0.5 D (1–180 degrees) respectively. No significant corneal curvature changes were detected between premenopausal and postmenopausal groups ($P > 0.05$). However, their study included premenopausal and postmenopausal women whereas our study included only postmenopausal women and we found that mean horizontal corneal curvature was more and mean vertical corneal curvature was less in postmenopausal women with meibomian gland dysfunction however above results were not statistically significant.

On the other hand, study of Aydin E, Demir HD, Demirturk F, Caliskan AC, Aytan H, Erkorkmaz U showed negative but significant correlation between horizontal corneal curvature and estrogen levels in postmenopausal women ($r = -0.346$, $p = 0.038$) [7]. In postmenopausal women, corneal steeping was observed minimally when compared to premenopausal women. The results suggest that changes in estrogen level of women with menopause are associated with slight alteration of horizontal curvature of cornea. However, our study inferred that estrogen levels in postmenopausal women with meibomian gland dysfunction was positively correlated to K1 and negatively correlated to K2 ($r = -0.112$) but was not statistically significant, and estrogen levels in postmenopausal women without meibomian gland dysfunction was positively correlated to K1 and K2 but was not statistically significant (Table 9).

Table 4 describes the comparison of K1, K2, CD, CV and HEX between the two groups, and it was inferred that the mean endothelial cell density was more in postmenopausal women with MGD, whereas mean coefficient of variation of endothelial cells and percentage of hexagonal cells of cornea was more in postmenopausal women MGD but not statistically significant.

Our study highlighted that the mean CCT was reduced in case of postmenopausal women with MGD when compared to postmenopausal women without MGD (Table 6). This is in concurrence with a study done by Juan A Sanchis *et al.* where it was concluded that postmenopausal women with dry eye have reduced CCT as compared to those without dry eye.[5] Salman IA *et al*. conducted a similar study in which they evaluated 40 eyes of 20 patients with MGD (mean age 40.55 ± 10.7 years) and forty eyes of 20 healthy individuals (mean age 39.25 ± 11.1 years) without any ophthalmic or systemic pathology as a control group and they concluded that CCT measurements did not differ in patients with MGD when compared with healthy control subjects. However, our study included only postmenopausal women with and without MGD and we found that there was reduced CCT in postmenopausal women with MGD when compared to postmenopausal women without MGD. Another study conducted by Ilknur Akyol Salman *et al*. showed that there was no statistically significant difference in mean CCT measurement in the MGD group in comparison with the control group ($p > 0.05$) [6]. Although it must be mentioned that the above study was not conducted in postmenopausal women.

A study conducted Sanchis-Gimeno Juan A *et al*. to compare the CCT of postmenopausal women with and without dry eye showed that mean corneal thickness was significantly reduced in postmenopausal women with dry eye ($p < 0.001$) [7]. The central cornea had the thinnest mean values in dry eyes and normal eyes (533.10 ± 4.74 micron and 547.63 ± 15.11 micron) whereas superonasal cornea had thicker mean values in dry eyes and normal eyes (632.3 ± 6.11micron and 648.78 ± 14.98 microns) respectively. The study concluded that postmenopausal women with dry eye have lower corneal thickness values than postmenopausal women without dry eye which was in concurrence with our study.

Another study conducted by S Rashmi *et al*. had similar results as ours although the study compared postmenopausal women to those of reproductive age group. They found that postmenopausal women had significantly thinner CCT as compared to women in reproductive age group (534.50 ± 12.13 microns, 558.18 ± 9.15 microns respectively ($p < 0.001$) [8]. This revelation warrants the need of accurate and periodic CCT measurements in every woman especially after refractive surgery. One of the advantages of our study is that it provided considerable insight to the hormonal status and its correlation with MGD and central corneal thickness thereby providing a better understanding. FSH values were lower in postmenopausal women with MGD as compared to those without MGD. Estrogen and progesterone levels were higher in postmenopausal women without MGD but were not statistically significant.

On further analysis of hormonal status and its relation with other variables such as FSH. TBUT and Schirmer's I test, it was found that the results were not statistically significant. Hence further studies are required in this field.

6. Conclusion

Central corneal thickness was considerably less in postmenopausal women with MGD as compared to those without MGD. CCT assessment must be considered in every woman, especially in elderly patients so as to avoid the chances of misdiagnosing cases of glaucoma. Corneal changes occur after menopause and it has an impact on detection and monitoring of corneal problems and glaucoma. It is essential to recalculate the applanated intraocular pressure according to CCT periodically. This helps in monitoring of glaucoma patients with precision. More studies are required to assess the correlation between hormone levels and MGD as the findings in our study were not statistically significant. This can help in the early detection and prompt management of dry eye and its complications.

7. References

1. Edwards TK. Jeffcoate's Principles of Gynaecology. 8th ed., Jaypee Brother Medical Publisher, 2014, 832.
2. Macsai MS. The role of omega-3 supplementation in

blepharitis and meibomian gland dysfunction (an AOS thesis). Trans Am Ophthalmol Soc 2008;106:336-356.
3. Kelly Nichols K, Gary Foulks N, Anthony Bron J, Ben Glasgow J, Murat Dogru, Kazuo Tsubota, *et al*. The International Workshop on Meibomian Gland Dysfunction: Executive Summary. Invest. Ophthalmol. Vis. Sci 2011;52(4):1922-1929.
4. Driver PJ, Lemp MA. Seborrhoea and meibomian gland dysfunction. In: Krachmer JH, Mannis MJ, Holland EJ, eds.Cornea: Fundamentals, Diagnosis and Management. Philadelphia: Elsevier Mosby 2005;1:485-491.
5. Salman AI, Azizi S, Mumcu U, Öndas O, Baykal O. Central corneal thickness in patients with meibomian gland dysfunction. Clin Exp Optom 2011;94(5):464-467.
6. Aydin E, Demir HD, Demirturk F, Caliskan AC, Aytan H, Erkorkmaz U. Corneal topographic changes in premenopausal and postmenopausal women. BMC Ophthalmology 2007;7:9.
7. Sanchis-Gimeno, Juan A *et al*. Reduced corneal thickness values in postmenopausal women with dry eye. Cornea 2005;24(1):39-44.
8. Rashmi S, Soman S, Anupama B, Hedge V, Jain R, Akshaya KM. Do Postmenopausal Women have Thinner Central Corneal Thickness as Compared to Women in Reproductive International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Index Copernicus Value | Impact Factor 2013-14;6.14:5.611.