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Original Research Article

ASSOCIATION BETWEEN DURATION OF MENOPAUSE, TEAR FILM PARAMETERS, AND MEIBOMIAN GLAND DYSFUNCTION IN POSTMENOPAUSAL WOMEN

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ABSTRACT

Background: Hormonal changes following menopause contribute to alterations in tear film stability and meibomian gland function, increasing the risk of dry eye disease in postmenopausal women. The objective is to evaluate the association between duration of menopause, tear film parameters, and meibomian gland dysfunction in postmenopausal women attending a tertiary care hospital.

Materials and Methods: This hospital-based cross-sectional observational study included 140 postmenopausal women. Participants were categorized according to duration of menopause (≤5 years, 6–10 years, and >10 years). All underwent comprehensive ophthalmic examination including Tear Film Break-Up Time (TBUT), Schirmer's test, Ocular Surface Disease Index (OSDI) assessment, and evaluation of meibomian gland dysfunction. Statistical analysis was performed using SPSS version 25.0. Associations were analyzed using one-way ANOVA, Chi-square test, and correlation analysis.

Results: The majority of participants were aged 51–60 years (45.7%), and 39.3% had experienced menopause for 6–10 years. Increasing duration of menopause was associated with significant reductions in TBUT (11.6 ± 2.4 to 7.1 ± 2.3 seconds) and Schirmer's test values (17.8 ± 4.2 to 10.8 ± 3.7 mm), while OSDI scores increased significantly (18.9 ± 6.5 to 33.8 ± 8.6) ($p<0.001$). Moderate-to-severe meibomian gland dysfunction was significantly more frequent in women with menopause lasting more than 10 years ($p<0.001$). Duration of menopause demonstrated significant negative correlations with TBUT ($r = -0.61$) and Schirmer's test ($r = -0.56$), and positive correlations with OSDI score ($r = 0.65$) and meibomian gland dysfunction severity ($r = 0.59$) ($p<0.001$).

Conclusion: Prolonged duration of menopause is significantly associated with deterioration of tear film function and increasing severity of meibomian gland dysfunction. Early ophthalmic evaluation and regular screening for dry eye disease in postmenopausal women may facilitate timely intervention and improve ocular surface health.

Keywords: Menopause, dry eye disease, tear film breakup time, Schirmer's test, meibomian gland dysfunction, postmenopausal women, ocular surface disease.

INTRODUCTION

Menopause is a natural physiological process characterized by permanent cessation of menstruation due to loss of ovarian function and declining estrogen levels. These hormonal changes affect multiple organ systems, including the ocular surface. Dry eye disease (DED) is one of the most common ocular disorders among postmenopausal women and is characterized by loss of tear film

homeostasis resulting in ocular discomfort, visual disturbance, and reduced quality of life.[1]

The prevalence of dry eye disease increases with advancing age and is significantly higher in women after menopause. Hormonal alterations, particularly estrogen and androgen deficiency, adversely affect tear secretion and meibomian gland function, making postmenopausal women more susceptible to ocular surface disorders.[2] Accurate evaluation of tear film abnormalities is essential for diagnosis and includes objective assessments such as Tear Film Break-Up Time (TBUT), Schirmer's test, ocular surface staining, and meibomian gland examination, as recommended by the TFOS DEWS II Diagnostic Methodology Report.[3]

Meibomian gland dysfunction (MGD), the leading cause of evaporative dry eye, is characterized by obstruction of the gland ducts and altered meibum secretion, resulting in increased tear evaporation and tear film instability.[4] Structural and functional changes in the meibomian glands become more common with aging and frequently coexist with aqueous-deficient dry eye, making early recognition and grading of MGD clinically important.[5]

Previous epidemiological studies have shown that the prevalence and severity of meibomian gland dysfunction increase with age and hormonal deficiency in postmenopausal women.[6] Furthermore, advances in non-contact infrared meibography have enabled objective assessment of meibomian gland morphology and gland dropout, improving the evaluation of ocular surface changes associated with menopause.[7]

Despite the growing burden of dry eye disease among postmenopausal women, limited Indian data are available regarding the relationship between duration of menopause, tear film parameters, and meibomian gland dysfunction. Therefore, the present study was undertaken to evaluate this association in postmenopausal women attending a tertiary care hospital.

MATERIALS AND METHODS

Study Design: This was a hospital-based cross-sectional observational study conducted to evaluate the association between duration of menopause, tear film parameters, and meibomian gland dysfunction in postmenopausal women.

Study Setting: The study was conducted in the Department of Ophthalmology of a tertiary care hospital.

Study Duration: The study was conducted over a period of 18 months.

Study Population: Postmenopausal women attending the Ophthalmology Outpatient Department (OPD) during the study period were screened for eligibility.

Sample Size: A total of 140 postmenopausal women were included in the study.

Sampling Technique: Eligible participants were recruited by consecutive sampling until the required sample size was achieved.

Inclusion Criteria

- Women aged 45 years and above with natural menopause (amenorrhea for at least 12 consecutive months).
- Willing to participate in the study.
- Able to undergo complete ophthalmic examination and tear film evaluation.

Exclusion Criteria

- History of ocular trauma or ocular surgery within the preceding six months.
- Active ocular infection or allergic conjunctivitis.
- Contact lens wear within the previous three months.
- Autoimmune disorders causing dry eye (e.g., Sjögren syndrome).
- Current use of topical ocular medications other than lubricants.
- Hormone replacement therapy.
- Eyelid abnormalities or previous eyelid surgery.

Study Procedure:

After obtaining informed consent, demographic details including age, duration of menopause, systemic illnesses, and medication history were recorded using a structured proforma.

All participants underwent a comprehensive ophthalmic examination including:

- Best-corrected visual acuity.
- Slit-lamp biomicroscopy.
- Assessment of lid margin abnormalities.
- Meibomian gland expressibility and meibum quality grading.
- Tear film evaluation included:
- Tear Film Break-Up Time (TBUT).
- Schirmer's Test I (without anesthesia).
- Ocular Surface Disease Index (OSDI) questionnaire.
- Corneal fluorescein staining graded using the Oxford grading scale.

Meibomian gland dysfunction was graded according to the recommendations of the International Workshop on Meibomian Gland Dysfunction.

Participants were categorized according to duration of menopause:

- ≤5 years
- 6–10 years
- 10 years

Outcome Measures

Primary Outcome

- Association between duration of menopause and tear film parameters (TBUT, Schirmer's test, and OSDI score).

Secondary Outcomes

- Prevalence and severity of meibomian gland dysfunction.
- Association between duration of menopause and meibomian gland dysfunction.

- Correlation between tear film parameters and meibomian gland dysfunction severity.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Comparisons among menopause-duration groups were performed using one-way ANOVA for continuous variables and the Chi-square test or Fisher's exact test for categorical variables. Correlations between duration of menopause, tear film parameters, and meibomian gland dysfunction scores were assessed using Pearson's or Spearman's correlation coefficient, as appropriate. Multivariable linear or logistic regression analysis was performed to identify independent predictors of tear film abnormalities and meibomian gland dysfunction. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 140 postmenopausal women were included in the study. The majority of participants were aged 51–60 years, and most had attained menopause 6–10 years before presentation. Tear film abnormalities and meibomian gland dysfunction increased progressively with increasing duration of menopause. Women with longer duration of menopause demonstrated significantly lower Tear Film Break-Up Time (TBUT), reduced Schirmer's test values, and higher prevalence of moderate-to-severe meibomian gland dysfunction.

Table 1: Baseline Characteristics of the Study Participants (n = 140)

Variable	Number	Percentage (%)
Age Group (years)		
45–50	32	22.9
51–60	64	45.7
>60	44	31.4
Duration of Menopause		
≤5 years	42	30.0
6–10 years	55	39.3
>10 years	43	30.7
Diabetes Mellitus		
Present	36	25.7
Absent	104	74.3
Hypertension		
Present	48	34.3
Absent	92	65.7

Most participants were 51–60 years old (45.7%), and the largest proportion had experienced menopause for 6–10 years (39.3%). Diabetes mellitus and hypertension were present in 25.7% and 34.3% of participants, respectively.

Table 2: Tear Film Parameters According to Duration of Menopause

Duration of Menopause	TBUT (seconds) Mean ± SD	Schirmer's Test (mm) Mean ± SD	OSDI Score Mean ± SD	p-value
≤5 years (n=42)	11.6 ± 2.4	17.8 ± 4.2	18.9 ± 6.5	
6–10 years (n=55)	9.3 ± 2.6	14.2 ± 3.9	25.7 ± 7.4	
>10 years (n=43)	7.1 ± 2.3	10.8 ± 3.7	33.8 ± 8.6	<0.001*

***Statistically significant:** Increasing duration of menopause was significantly associated with reduced TBUT, lower Schirmer's test values, and higher OSDI scores, indicating progressive deterioration of tear film stability and worsening dry eye symptoms.

Table 3: Severity of Meibomian Gland Dysfunction According to Duration of Menopause

Duration of Menopause	No MGD	Mild MGD	Moderate MGD	Severe MGD	p-value
≤5 years (n=42)	18 (42.9%)	15 (35.7%)	8 (19.0%)	1 (2.4%)	
6–10 years (n=55)	12 (21.8%)	21 (38.2%)	17 (30.9%)	5 (9.1%)	
>10 years (n=43)	5 (11.6%)	10 (23.3%)	18 (41.9%)	10 (23.3%)	<0.001*

***Statistically significant:** The prevalence and severity of meibomian gland dysfunction increased significantly with increasing duration of menopause. Women with menopause lasting more than 10 years had the highest frequency of moderate and severe MGD.

Table 4: Correlation Between Duration of Menopause and Tear Film Parameters

Variable	Correlation Coefficient (r)	p-value
TBUT	-0.61	<0.001*
Schirmer's Test	-0.56	<0.001*
OSDI Score	0.65	<0.001*
Meibomian Gland Dysfunction Grade	0.59	<0.001*

***Statistically significant:** Duration of menopause showed a significant negative correlation with TBUT and Schirmer's test values, indicating worsening tear film function with increasing menopausal duration. Conversely, there was a significant positive correlation between duration of menopause, OSDI score, and meibomian gland dysfunction severity, suggesting progressive ocular surface disease in women with longer postmenopausal duration.

DISCUSSION

Menopause is associated with progressive hormonal changes that adversely affect the ocular surface, tear film stability, and meibomian gland function. Declining androgen and estrogen levels alter meibomian gland secretion and tear film homeostasis, predisposing postmenopausal women to evaporative dry eye disease. The present study evaluated the association between duration of menopause, tear film parameters, and meibomian gland dysfunction (MGD) in postmenopausal women. The findings demonstrated that increasing duration of menopause was significantly associated with reduced tear film stability, decreased aqueous tear secretion, higher dry eye symptom scores, and greater severity of MGD.

The present study demonstrated a progressive increase in the severity of meibomian gland dysfunction with increasing duration of menopause. Women with menopause lasting more than ten years showed the highest prevalence of moderate and severe MGD. Similar observations were reported by Arita et al., who described age-related structural alterations of the meibomian glands using non-contact infrared meibography and demonstrated that gland dropout and morphological abnormalities increase with advancing age, contributing to tear film instability and evaporative dry eye disease.[8]

Hormonal alterations play a crucial role in ocular surface homeostasis. The TFOS DEWS II Sex, Gender, and Hormones Report by Sullivan et al. emphasized that androgen deficiency occurring after menopause impairs lipid secretion from the meibomian glands, resulting in increased tear evaporation and ocular surface inflammation. The present findings of worsening tear film parameters and increasing MGD with longer duration of menopause are in agreement with these observations.[9]

The higher prevalence of dry eye symptoms among women with prolonged menopause observed in this study also corresponds with the findings of Vehof et al., who reported that women, particularly after menopause, experience significantly greater prevalence and severity of dry eye disease than men because of hormonal, immunological, and environmental influences. Their study highlighted female sex and advancing age as important determinants of ocular surface disease.[10]

In the present study, tear film breakup time (TBUT) and Schirmer's test values showed significant reductions with increasing duration of menopause, whereas Ocular Surface Disease Index (OSDI) scores increased significantly. Similar observations were reported by Uchino and Schaumberg, who demonstrated that deterioration in tear film function is associated with worsening visual symptoms, reduced daily functioning, and impaired quality of life in patients with dry eye disease. Early recognition and treatment therefore play an important role in preventing chronic ocular discomfort.[11]

The findings are also consistent with the International Dry Eye Workshop (DEWS 2007), which identified tear film instability and tear hyperosmolarity as central mechanisms responsible for ocular surface damage in dry eye disease. The present study demonstrated that longer duration of menopause was associated with progressive impairment of tear film stability, supporting the concept that hormonal deficiency contributes significantly to ocular surface dysfunction.[12]

The TFOS DEWS II Pathophysiology Report by Bron et al. further explained that tear film instability initiates a self-perpetuating cycle involving hyperosmolarity, inflammation, epithelial damage, and neurosensory abnormalities, resulting in progressive worsening of dry eye disease. The significant negative correlation between duration of menopause and TBUT observed in the present study supports this pathogenic mechanism.[13]

Management of postmenopausal dry eye requires early diagnosis and comprehensive treatment. The TFOS DEWS II Management and Therapy Report recommended individualized management strategies including patient education, environmental modification, ocular lubricants, eyelid hygiene, warm compresses, and treatment of meibomian gland dysfunction. Identification of women at greater risk based on menopausal duration may facilitate timely intervention and improve long-term ocular surface health.[14]

Baudouin et al. emphasized that meibomian gland dysfunction represents a major contributor to the "vicious cycle" of dry eye disease through persistent lipid deficiency, increased tear evaporation, and chronic inflammation. The present study similarly demonstrated that increasing duration of menopause was associated with greater severity of MGD and worsening tear film parameters, reinforcing the importance of routine meibomian gland assessment in postmenopausal women.[15]

Overall, the present study highlights that prolonged duration of menopause is associated with progressive deterioration of tear film function and increasing meibomian gland dysfunction. Early ophthalmic evaluation and appropriate management may reduce symptoms, improve ocular surface health, and enhance quality of life in postmenopausal women.

CONCLUSION

Longer duration of menopause was significantly associated with worsening tear film parameters and increasing severity of meibomian gland dysfunction among postmenopausal women. Tear Film Break-Up Time and Schirmer's test values decreased progressively, while dry eye symptoms and meibomian gland dysfunction increased with advancing menopausal duration. Routine ophthalmic screening, including tear film evaluation and meibomian gland assessment, should be considered in postmenopausal women, particularly those with prolonged menopause, to facilitate early diagnosis and timely management of ocular surface disease.

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