의학석사 학위논문

건성안 환자와 정상 대조군에서 눈물막 지질층 두께와 눈물 증발량 사이의 연관성 고찰

Correlation Between Tear Film Lipid Layer Thickness and Water Evaporation in Patients with Dry Eye Disease and in Healthy Controls

2021년 2월

서울대학교 대학원
의학과 안과학 전공
윤도예

의학 석사 학위논문

건성안 환자와 정상 대조군에서 눈물막 지질층 두께와 눈물 증발량 사이의 연관성 고찰

Correlation Between Tear Film Lipid Layer Thickness and Water Evaporation in Patients with Dry Eye Disease and in Healthy Controls

2021년 2월

서울대학교 대학원
의학과 안과학 전공

건성안 환자와 정상 대조군에서 눈물막 지질층 두께와 눈물 증발량 사이의 연관성 고찰

Correlation Between Tear Film Lipid Layer Thickness and Water Evaporation in Patients with Dry Eye Disease and in Healthy Controls

지도교수 현준영

이 논문을 윤도예 석사 학위논문으로 제출함

2020년 10월

서울대학교 대학원

의학과 안과학 전공

윤도예

윤도예의 석사 학위논문을 인준함

2021년 1월

위 원 장 박 유 형 (인)

부위원장 현 준 영 (인)

위 원 김 정 훈 (인)

Abstract

Correlation Between Tear Film Lipid Layer Thickness and Water Evaporation in Patients with Dry Eye Disease and in Healthy Controls

Do Yeh Yoon
Medicine, Department of Ophthalmology
The Graduate School
Seoul National University

Purpose: To evaluate the correlation between tear film lipid layer thickness and water evaporation in patients with short tear break-up time (TBUT) type dry eye disease and healthy controls.

Methods: This prospective study included 25 eyes of patients with short TBUT type dry eye disease and 25 eyes of healthy controls. Tear film lipid layer thickness was measured using an interferometer, and water evaporation in the ocular area was measured using a Tewameter TM300 with custom-made goggles. The correlation between tear film lipid layer thickness and water evaporation was evaluated. Other parameters such as TBUT, Schirmer I score, ocular surface staining, presence and type of meibomian gland dysfunction (MGD), ocular surface disease index (OSDI), and visual analog scale (VAS) scores were also evaluated.

Results: Tear film lipid layer thickness did not show a significant correlation with water evaporation in the ocular area measured using a Tewameter TM300. However, tear film lipid layer thickness was significantly correlated with tear break-up time (P = 0.017) and ocular surface staining by NEI (National Eye Institute) scheme (P = 0.03). Water evaporation showed positive correlation with the Schirmer I score (P = 0.017).

Conclusions: The tear film lipid layer moreso affected the stability of the tear film than the amount of tear evaporation in patients with short TBUT dry eye and healthy controls.

Keywords:
tear film lipid layer thickness; water evaporation; dry eye disease
Student Number: 2018-22278

Table of Contents

Table

Figure

Chapter 1. Introduction

Dry eye disease (DED) is a chronic multifactorial disease of the ocular surface and tear film and is one of the most common ocular diseases. The TFOS Dry Eye Workshop II (TFOS DEWS II) defined DED as an ocular surface disease that is characterized by 1) a loss of homeostasis of the tear film and 2) ocular symptoms, including tear film instability and hyperosmolarity, ocular surface inflammation, and damage of ocular surface.[1] DED is classified into two etiological subtypes: aqueous deficiency (ADDE) and evaporative (EDE), but clinically there is frequent co-existence and overlap of the subtypes.

Excessive tear evaporation, which leads to tear hyperosmolarity and results in ocular surface inflammation, is considered a key factor that induces a vicious cycle in the pathogenesis of DED.[1]

In a three-layered model of tear film, a tear film lipid layer has been recognized as a barrier to tear evaporation.[2, 3] Recent advances in technology using interferometry can measure the lipid layer thickness (LLT) in tear film. However, direct measurement of tear evaporation is not feasible in clinical practice. A few reported studies have measured tear evaporation using a closed chamber system, ventilating chamber system, or infrared thermography in research settings.[4-7] In a previous study, we measured transepidermal water loss (TEWL) from the ocular area using a Tewameter TM300 in moderate to severe cases of DED and showed that TEWL may reflect tear evaporation.[8]

The purpose of this study was to investigate the correlation between LLT, TEWL, and other DED parameters including the status of meibomian gland dysfunction (MGD). We hypothesized that tear film

LLT can affect TEWL from the ocular area.

Chapter 2. Methods

2.1. Participants

This single-center, prospective case-control study included 25 eyes of 25 patients with mild DED (dry eye workshop dry eye severity level ≤1)[9] and 25 eyes of 25 age-matched healthy subjects as controls. The study was conducted in accordance with the tenets of the Declaration of Helsinki, and the study protocol was approved by the Institutional Review Board of Seoul National University Bundang Hospital (No: B-1807/483-104). Data of patients who fulfilled the following diagnostic criteria were collected: 1) age of 20 years or older, 2) presence of ocular symptoms and tear break-up time (TBUT) less than 5 seconds, 3) dry eye severity level ≤1 according to the Dry Eye Workshop[9] (Figure 1), 4) absence of history of ocular surgery, injury, and allergy, and 5) no use of anything other than non-preserved artificial tears. Exclusion criteria included Sjogren's syndrome, contact lens use, systemic disease or medication use that may cause DED, skin disease that may affect evaporation, and an MGD severity level ≥ 4.[10]

MGD was not excluded from the control group, because we wanted to see the correlation between LLT and TEWL in all subjects. So the two groups were similarly matched for the degree of MGD.

Potential participants were screened for eligibility, and written informed consent was sought from each participant by an investigator after explanation of the nature and possible consequences of the study.

2.2. TEWL Measurement

The Tewameter® TM 300 (Courage & Khazaka Electronics GmbH, Cologne, Germany) measures the density gradient of water evaporation from the skin indirectly using the two pairs of sensors (temperature and relative humidity) inside the hollow cylinder.[8] Using a customized goggle-like adapter cap, this device can be used to measure TEWL from the ocular surface and periorbital skin.[8] The measurements were performed in a test room equipped with a thermo-hygrostat (room temperature, 24 – 26 °C; relative humidity, 35 – 45 °C). After the participant sat in the room for a 10-minute equilibration period, an experienced investigator (HEJ) performed the TEWL measurements at 1-second intervals until the values reached a plateau. The average of five values and the time taken to reach a plateau were used for further analyses. The participants were instructed to look forward with their eyes blinking normally during the recording.

2.3. Dry Eye Parameters

The dry eye parameters that were obtained included TBUT, ocular staining scores (OSS), Schirmer-I test values, the ocular surface disease index (OSDI), visual analogue scale (VAS) scores as symptom scores, tear osmolarity, and tear matrix metallopeptidase 9 (MMP-9). All parameters were assessed in the same test room as described above.

To obtain the TBUT measurements, 0.25% fluorescein dye was instilled into the eye of the subject, and the tear film was observed using a biomicroscope with a cobalt blue filter. The subject was instructed to blink a few times and then to keep their eyes open as long as possible. The time from the subject's blink to the first black spot within the tear film was measured. The OSS was assessed using the NEI (National Eye Institute) scale. Corneal staining scores were assessed by fluorescein staining using a slit lamp cobalt blue filter 1 min after a drop of 0.25% sterile fluorescein was instilled into the conjunctival sac. The cornea was divided into five regions (nasal, central, temporal, inferior, and superior), and a score from 0 (absent) to 3 (severe) was assigned to each region with a maximum total score of 15. We only analyzed the corneal staining score. All measurements were made by one examiner. For the Schirmer-I test, a standard Schirmer test strip (5 × 40 mm) was placed in the inferior conjunctival sac at the outer third of the inferior lid. The patients were instructed to keep their eyes closed during the test, and the amount of wetting was recorded after five min. The OSDI questionnaire (Allergan, Inc., Irvine, CA, USA) consists of 12 questions related to symptoms within the past week and yields total scores ranging from 0 (least severe) to 100 (most severe). The VAS system consisted of three questionnaires, each with an answer scale ranging from 0 (none) to 10 (very severe) for dryness, foreign body sensation, and pain. Therefore, the total VAS score ranged from 0 to 30. Tear osmolarity was measured using a TearLab Osmolarity System (TearLab Corp., San Diego, CA, USA). Tear samples (50 nL) were collected from the inferior lateral meniscus and analyzed simultaneously. The tear MMP-9 test was performed using a commercially available test kit (InflammaDry; Quidel Corp., San Diego, CA, USA).

2.4. Lipid Layer Thickness Measurement and Meibography

LLT was measured using LipiView® Interferometry (TearScience Inc, Morrisville, NC, USA) by analyzing more than one billion data points of the interferometric image of the tear film. The observed color is related to the LLT and is presented in "interferometric color units" in which 1 interferometric color unit corresponds to approximately 1 nm.[11] The average tear film LLT from all frames was recorded for each study participant. Images of meibography were also obtained using LipiView® Interferometry from the lower lid and graded using a 0 to 3 point scale, with 0 as no dropout, 1 as ≤33%, 2 as 34%-66%, and 3 as ≥66%[12].

2.5. Statistical Analysis

The data were taken from the eye with a shorter TBUT for statistical analysis. If the TBUT was the same in both eyes, we chose the eye with a thinner lipid layer.

Statistical analyses were performed using SPSS® version 22.0 (IBM Corp., Armonk, NY, USA) and the Mann-Whitney U test was used to compare the dry eye parameters including TEWL and time to reach the plateau between the DED and control groups. The average of five values of TEWL and time-to-plateau were calculated. Pearson's correlation test and multiple regression analysis were used to assess the correlations between TEWL and other parameters. All values are expressed as the mean ± standard deviation (SD). A *P*-value <0.05 was considered statistically significant.

Chapter 3. Results

The demographic characteristics and parameters of interest are presented in Table 1. Data were analyzed from 50 subjects, with a mean age of 35.46 ± 10.38. The mean room temperature was 25.01 ± 1.70°C and the mean relative humidity of the examination room was 35.23 ± 7.49%. Fifty eyes were included in the DED and control groups (25 per group); 12 DED patients and 6 individuals in the control group had MGD.

As expected, the TBUT was shorter and the NEI score was higher in the DED group (P = 0.000 and P = 0.000, respectively, Mann-Whitney U test). The LLT and meibography grade of the DED group were significantly higher than those of the control group (P = 0.000 and P = 0.007, respectively, Mann-Whitney U test). The time to plateau was significantly higher in the DED group (P = 0.001, Mann-Whitney U test). These results indicate that LLT has no effect on tear evaporation, and tear evaporation has no relation to LLT (P = 0.1929, Pearson's correlation test). To assess the effect of coexisting MGD on TEWL, we performed a subgroup analysis in the two groups (Table 2). There was no statistical difference in TEWL between the four groups. However, the time-to-plateau was significantly different between the DED with MGD group and the control group without MGD (42.45 ± 30.94 s, 16.05 ± 6.00 s, respectively; P = 0.018, Mann-Whitney U test).

We also analyzed the correlation between TEWL and other DED parameters in the three groups (all participants, DED group, and the control group) using multiple regression analysis (Figure 2). In all participants, TEWL was correlated with Schirmer 1 test values (P = 0.017) and time-to-plateau (P = 0.023). In patients with short TBUT

DED, TEWL tends to increase as tear volume increases (Figure 5-A). Time-to-plateau showed no correlation with any other DED parameters in all participants. In the DED group, TEWL was correlated with the Schirmer 1 test (P = 0.001) and NEI score (P = 0.044). Time-to-plateau showed no correlation with any other DED parameters in the DED group. In the control group, TEWL and time-to-plateau were not correlated with other DED parameters. Among the DED parameters, TBUT and NEI were found to be related to LLT (P = 0.004 and P = 0.035, respectively); TBUT tended to decrease when the LLT was abnormally thick (Figure 5-B).

Chapter 4. Discussion

This study included patients with short TBUT dry eye and healthy controls. Short TBUT dry eye is characterized by a TBUT of less than 5 s with minimal vital staining and normal tear production. Short TBUT-type dry eye is characterized by TBUT of less than 5 seconds and dry eye symptoms such as ocular fatigue or dryness; the importance of this type has recently been gaining prominence.[13] We chose this subtype of DED to minimize the effects of a compromised ocular surface or severe desiccation on the results.

In previous studies, LLT was found to be positively correlated with TBUT,[14-16] the MGD dropout grade[16], and the Schirmer 1 test score.[14] Increased age, female sex, hypersecretory MGD, and lid margin inflammation were significantly related to increased LLT.[17] In one study, it was reported that there was a correlation between the severity of dry eye symptom and LLT,[18] but another study reported that there was no correlation.[16] The results showed that LLT is not significantly correlated with TEWL. This is a somewhat unexpected finding because the lipid layer is thought to be an important barrier to excessive tear evaporation in the traditional three-layered tear film model. LLT showed a significant correlation with TBUT in this study. Local regression implies that TBUT starts to decrease when the lipid layer is thicker than 80 nm. TBUT in hypersecretory MGD was decreased compared to non-MGD or obstructive MGD; however, these differences were marginally insignificant. These findings suggest that the tear film lipid layer does not protect the aqueous tear evaporation, but rather maintains the stability of the tear film.

While TEWL did not show a significant correlation with LLT, it was positively correlated with the Schirmer-I test value in patients with short TBUT dry eye and healthy controls. Since TEWL was related to the Schirmer 1 test score rather than the LLT, this indicates that it is related to the amount of tears. Contrary to this finding, a previous study showed a negative correlation between TEWL and Schirmer I test values in moderate to severe DED.[8] Also, in the same study, TEWL values were significantly different between patients with moderate to severe DED and those in the control group,[8] but there was no difference between patients with mildly dry eyes and the control group in this study. These contradictory findings can be attributed to the difference in the study population between the two studies. Local regression in this study also suggests that TEWL may be negatively correlated with the Schirmer I test values when they are low.

The two main categories of DED are aqueous deficient and evaporative. The current understanding is that these two categories are not mutually exclusive, and there is frequent overlap and co-existence of the two subtypes. Unlike other DED parameters such as symptoms, tear production, tear film stability, and ocular surface staining, the term “evaporative” seems to be conceptual because there is no standardized method to measure tear film evaporation. In our study, we measured TEWL from the ocular area using a Tewameter TM300 with custom goggles, as reported previously.[8] Our study suggests that water evaporation is positively correlated with tear volume. It seems that excessive evaporation may play a role in DED in the setting of decreased tear production. The results also showed that the lipid layer may play an important role in the stabilization of tear film. This finding is somewhat interesting because excessive evaporation may contribute more to the aqueous deficient type than to the evaporative type. On the other hand, excessive evaporation may not be a key component in evaporative DED. Early break-up of the tear film in this subtype of DED may be attributed more to instability of tear film or loss of homeostasis in the component of tear film than to excessive tear evaporation.

To assess the effect of coexisting MGD, we performed subgroup analyses in the DED and control groups. The time-to-plateau was significantly different between the DED with MGD group and the control group without MGD (42.45 ± 30.94 s, 16.05 ± 6.00 s, respectively; P = 0.018, Mann-Whitney U test). Although the implication of time-to-plateau is not clear, it is thought to be related to tear film dynamics, and further research is needed.

Our study has some limitations. First, measuring TEWL from the ocular area is not a standard diagnostic method in DED. But in previous study showed that TEWL may reflect tear evaporation in moderate to severe dry eye patients.[8] Since there is no standardized method yet, sufficient follow-up studies are needed. Second, in this study, only mild DED group was evaluated. Since DED is heterogenous disease, we wanted to evaluate the tear film dynamics in the absence of damage to the ocular surface by limiting the study subjects.. Further studies are needed on the effects of various types of dry eye or accompanying factors such as MGD.

In conclusion, TEWL was not significantly different from the control group in mild short TBUT DED. Further, TEWL was significantly associated with Schirmer 1 test scores but not LLT. These results suggest that the LLT is related to the stability of the tear film and the ocular surface damage (NEI) rather than the amount of evaporation. As LLT affects tear film stabilzation rather than tear evaporation, it is thought that the treatment direction should be changed in the direction of stabilizing tear film rather than supplementing the amount of tear.

Bibliography

1. Bron AJ, de Paiva CS, Chauhan SK, et al. TFOS DEWS II pathophysiology report. *Ocul Surf.* 2017;15(3):438-510.
2. Bron AJ, Tiffany JM, Gouveia SM, Yokoi N, Voon LW. Functional aspects of the tear film lipid layer. *Exp Eye Res.* 2004;78(3):347-360.
3. Knop E, Knop N, Millar T, Obata H, Sullivan DA. The international workshop on meibomian gland dysfunction: report of the subcommittee on anatomy, physiology, and pathophysiology of the meibomian gland. *Invest Ophthalmol Vis Sci.* 2011;52(4):1938-1978.
4. Tsubota K, Yamada M. Tear evaporation from the ocular surface. *Invest Ophthalmol Vis Sci.* 1992;33(10):2942-2950.
5. Mathers WD, Binarao G, Petroll M. Ocular water evaporation and the dry eye. A new measuring device. *Cornea.* 1993;12(4):335-340.
6. Goto E, Endo K, Suzuki A, Fujikura Y, Matsumoto Y, Tsubota K. Tear evaporation dynamics in normal subjects and subjects with obstructive meibomian gland dysfunction. *Invest Ophthalmol Vis Sci.* 2003;44(2):533-539.
7. Rolando M, Refojo MF. Tear evaporimeter for measuring water evaporation rate from the tear film under controlled conditions in humans. *Exp Eye Res.* 1983;36(1):25-33.
8. Jeon HS, Youn SW, Jeon HE, Kim JH, Hyon JY. Assessment of transepidermal water loss from the ocular area in dry eye disease. *Invest Ophthalmol Vis Sci.* 2016;57(11):4831-4836.
9. Lemp MA, Foulks GN. The definition and classification of dry eye disease: report of the Definition and Classification Subcommittee of the International Dry Eye WorkShop (2007). *Ocul Surf.*

2007;5:75-92.
10. Tomlinson A, Bron AJ, Korb DR, et al. The international workshop on meibomian gland dysfunction: report of the diagnosis subcommittee. *Invest Ophthalmol Vis Sci.* 2011;52(4):2006-2049.
11. Blackie CA, Solomon JD, Scaffidi RC, Greiner JV, Lemp MA, Korb DR. The relationship between dry eye symptoms and lipid layer thickness. *Cornea.* 2009;28(7):789-794.
12. Arita R, Itoh K, Inoue K, Amano S. Noncontact infrared meibography to document age-related changes of the meibomian glands in a normal population. *Ophthalmology.* 2008;115(5):911-915.
13. Kazuo Tsubota, Short Tear Film Breakup Time-Type Dry Eye, *Invest Ophthalmol Vis Sci.* 2018 Nov 1;59(14):DES64-DES70.
14. Isreb MA, Greiner JV, Korb DR, et al. Correlation of lipid layer thickness measurements with fluorescein tear film break-up time and Schirmer's test. *Eye (Lond).* 2003;17(1):79-83.
15. Li Y, Li S, Zhou J, Liu C, Xu M. Relationship between lipid layer thickness, incomplete blinking rate and tear film instability in patients with different myopia degrees after small-incision lenticule extraction. *PLoS One.* 2020;15(3):e0230119.
16. Ji YW, Lee J, Lee H, Seo KY, Kim EK, Kim TI. Automated measurement of tear film dynamics and lipid layer thickness for assessment of non-sjogren dry eye syndrome with meibomian gland dysfunction. *Cornea.* 2017;36(2):176-182.
17. Jung JW, Park SY, Kim JS, Kim EK, Seo KY, Kim TI. Analysis of factors associated with the tear film lipid layer thickness in normal eyes and patients with dry eye syndrome. *Invest Ophthalmol Vis Sci.* 2016;57(10):4076-4083.
18. Foulks GN. The correlation between the tear film lipid layer and dry eye disease. *Surv Ophthalmol.* 2007;52(4):369-374.

Table 1. Clinical characteristics of the study participants

Variable	Control group (Mean ± SD or n [%])	DED group (Mean ± SD or n [%])	*P*-value (Mann-Whitney U test)
Number of eyes	25	25	
Female	21 (84.00%)	19 (76.00%)	
Male	4 (16.00%)	6 (24.00%)	
Age (yrs)	38.12 ± 12.57	38.12 ± 12.57	
TBUT (sec)	7.58 ± 0.94	2.56± 0.85	0.000*
Schirmer 1 test (mm)	16.46 ± 10.38	15.94 ± 10.66	0.580
NEI score	0.00 ± 0.00	2.54 ± 1.71	0.000*
LLT (nm)	60.33 ± 21.03	78.64 ± 23.18	0.000*
Meibography grade	0.22 ± 0.41	0.62 ± 0.77	0.007*
TEWL	51.85 ± 13.43	52.37 ± 16.38	0.828
Time-to-plateau (sec)	18.30 ± 10.26	40.02 ± 36.47	0.001*
Tear osmolarity (mOsm)	286.27 ± 7.09	287.74 ± 13.80	0.530
OSDI	18.19 ± 20.08	31.22 ± 22.76	0.587
VAS	3.67 ± 4.41	9.48 ± 6.84	0.007*
Positive MMP-9 (n)	8 (32%)	8 (32%)	

DED, dry eye disease; TBUT, tear film break-up time; NEI score, National Eye Institute score; LLT, lipid layer thickness; SD, standard deviation; TEWL, transepidermal water loss; VAS, visual analogue scale; OSDI, ocular surface disease index; MMP-9, tear matrix metallopeptidase 9.

*indicates statistically significant results

Table 2. Comparison of TEWL and time-to-plateau between the two groups according to the existence of MGD

Parameter	TEWL	Time-to-plateau	*P*-value (Mann-Whitney U test)
DED group			
- MGD (-)	52.64 ± 17.93	28.31 ± 39.00	
- MGD (+)	56.78 ± 20.02	42.45 ± 30.94	0.018*
Control			
- MGD (-)	54.22 ± 13.64	16.05 ± 6.00	
- MGD (+)	51.78 ± 14.33	22.50 ± 10.65	

Data are presented as the mean ± standard deviation. DED, dry eye disease; MGD, meibomian gland dysfunction; TEWL, transepidermal water loss. *indicates statistical significance.

Dry Eye Severity Level	1	2	3	4*
Discomfort, severity & frequency	Mild and/or episodic; occurs under environmental stress	Moderate episodic or chronic, stress or no stress	Severe frequent or constant without stress	Severe and/or disabling and constant
Visual symptoms	None or episodic mild fatigue	Annoying and/or activity-limiting episodic	Annoying, chronic and/or constant, limiting activity	Constant and/or possibly disabling
Conjunctival injection	None to mild	None to mild	+/−	+/++
Conjunctival staining	None to mild	Variable	Moderate to marked	Marked
Corneal staining (severity/location)	None to mild	Variable	Marked central	Severe punctate erosions
Corneal/tear signs	None to mild	Mild debris, ↓ meniscus	Filamentary keratitis, mucus clumping, ↑ tear debris	Filamentary keratitis, mucus clumping, ↑ tear debris, ulceration
Lid/meibomian glands	MGD variably present	MGD variably present	Frequent	Trichiasis, keratinization, symblepharon
TFBUT (sec)	Variable	≤ 10	≤ 5	Immediate
Schirmer score (mm/5 min)	Variable	≤ 10	≤ 5	≤ 2

*Must have signs AND symptoms. TBUT: fluorescein tear break-up time. MGD: meibomian gland disease

Reprinted with permission from Behrens A, Doyle JJ, Stern L, et al. Dysfunctional tear syndrome. A Delphi approach to treatment recommendations. *Cornea* 2006;25:90-7

Figure 1. Dry eye severity grading scheme

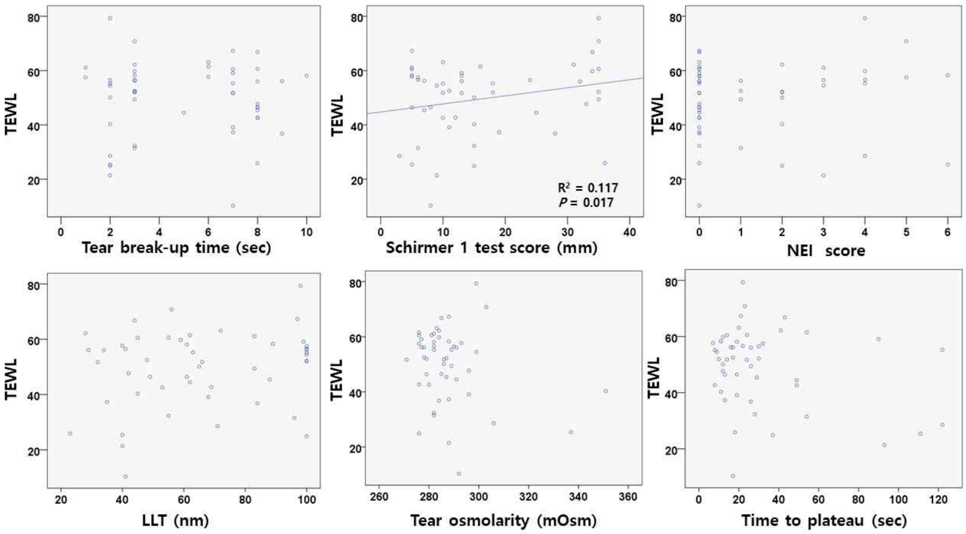

Figure 2. Correlation between TEWL and TBUT (A), Schirmer 1 test scores (B), NEI (National Eye Institute) scores (C), LLT (D), tear osmolarity (E), and time-to-plateau (F) in all participants. (B) Only Schirmer 1 test scores showed a statistically significant correlation with TEWL. TEWL, transepidermal water loss; LLT, lipid layer thickness; TBUT, tear break-up time.

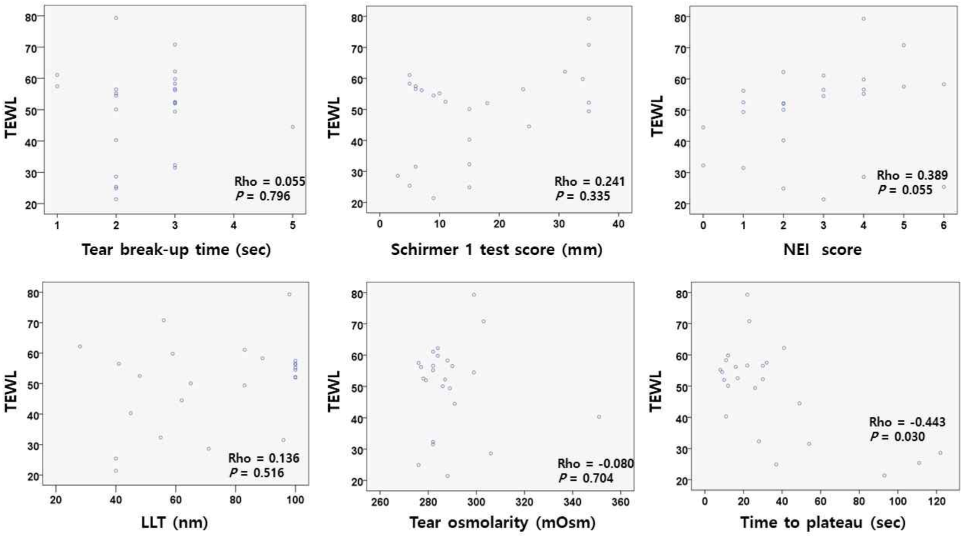

Figure 3. Correlation between TEWL and TBUT (A), Schirmer 1 test scores (B), NEI (National Eye Institute) scores (C), LLT (D), tear osmolarity (E), and time-to-plateau (F) in DED group. TEWL, transepidermal water loss; LLT, lipid layer thickness; TBUT, tear break-up time.

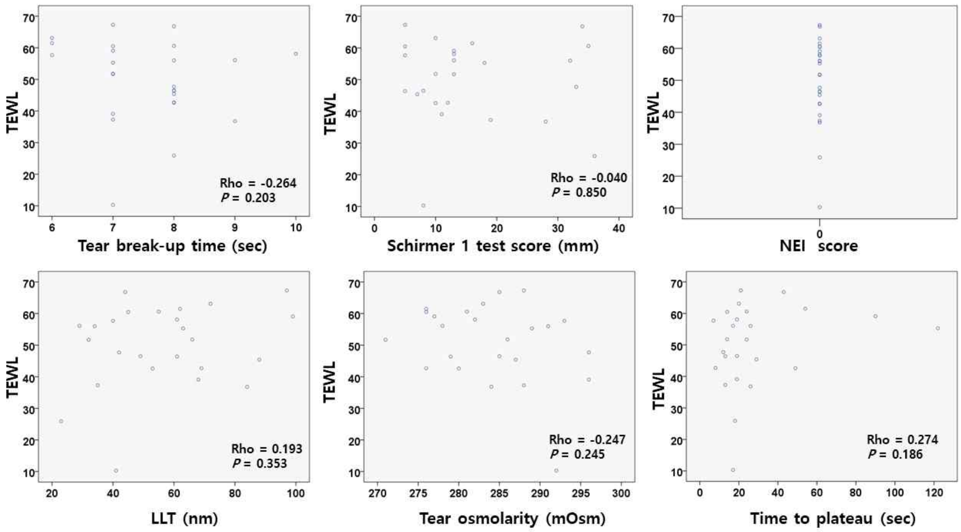

Figure 4 Correlation between TEWL and TBUT (A), Schirmer 1 test scores (B), NEI (National Eye Institute) scores (C), LLT (D), tear osmolarity (E), and time-to-plateau (F) in control group. TEWL, transepidermal water loss; LLT, lipid layer thickness; TBUT, tear break-up time.

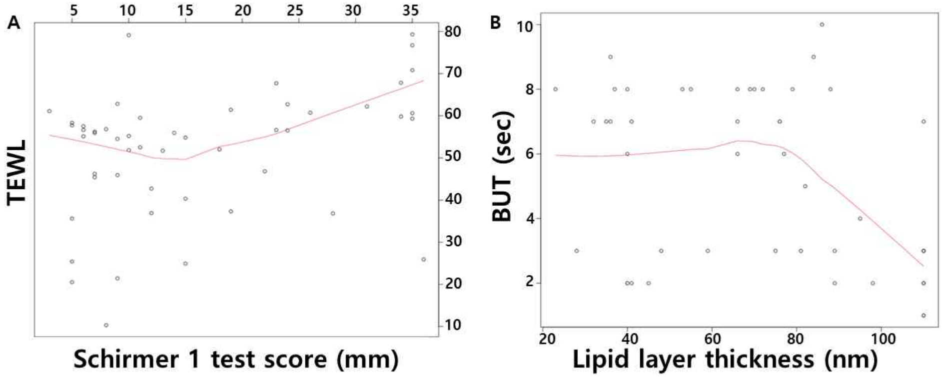

Figure 5. Correlation between TEWL and Schirmer 1 test scores (A), correlation between TBUT tear break-up time) and LLT (B) in all participants. (A) TEWL was correlated with Schirmer 1 test values (P = 0.017). (B) TBUT was significantly correlated with LLT (P = 0.004) and tended to decrease when LLT was abnormally thick. The red line represents the logically estimated scatterplot smoothing curve. TEWL, transepidermal water loss; LLT, lipid layer thickness; TBUT, tear break-up time.

국 문 초 록

건성안 환자와 정상 대조군에서 눈물막 지질층 두께와 눈물 증발량 사이의 연관성 고찰

윤도예

서울대학교 대학원

의학과 안과학 전공

목 적: 눈물막파괴시간이 짧은 건성안 환자와 건강한 대조군에서 눈물막 지질층 두께와 눈물 증발량 사이의 상관 관계를 평가한다.

방 법: 본 연구는 전향적 연구로서 눈물막 파괴시간이 짧은 건성안 환자 25안과 건성안이 없는 건강한 대조군 25안을 대상으로 하였다. 눈물막 지질층 두께는 눈물층 이미지 간섭계로 측정하였고 안구 영역 수분 증발량은 Tewameter TM300 장비와 특수 제작된 고글을 이용하여 측정하였다. 눈물 지질층 두께와 안구 영역 수분 증발량의 상관관계를 분석하였다. 눈물막파괴시간, 쉬르머 1 검사, 안구 표면 염색지수, 동반된 마이봄샘 기능장애의 정도, 안구 건조증 설문지표 (ocular surface disease index (OSDI), and visual analog scale (VAS)) 등도 함께 분석하였다.

결 과: 눈물막 지질층 두께는 Tewameter TM300 장비를 사용하여 측정한 안구 영역의 수분 증발량과 유의한 상관 관계를 보이지 않았다. 그러나 눈물막 지질층 두께는 눈물막파괴시간 (P = 0.004) 및 NEI (National Eye Institute) 방식에 의한 안구표면 염색지수(P = 0.035) 와

유의한 상관 관계를 보였다. 수분 증발은 쉬르머 1 검사 점수와 양의 상관 관계를 나타냈다(P = 0.017).

결 론: 눈물막 지질층은 눈물막파괴시간이 짧은 건성안 환자와 건강한 대조군에서 모두 눈물 증발량보다는 눈물막의 안정성에 영향을 미쳤다.

주요어 : 눈물막 지질층 두께, 눈물 증발량, 건성안

학 번 : 2018-22278