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Can lacrimal punctum size link to the severity of dry eye disease?

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Abstract:

To investigate if larger punctum size links to the severity of dry eye disease (DED) and perhaps, punctum size inspection can be adopted to become one of the DED evaluations for practitioners. The records of 200 eyes of 114 patients that had temporary collagen punctum plugs due to severe DED (Level 2 to Level 4) from January 1, 2017, to July 31, 2018, were reviewed for the size of the plugs. Lacrimal punctum size of those eyes was approximated according to the size of vertical canalicular soft collagen plug (from 0.3 to 0.5 mm diameter, Oasis, Lacrimedics, Glendora, CA, USA). The dry eye severity grading from the International Dry Eye WorkShop was used to grade the level of the severity of DED. Those eyes classified as Level 2 and above were considered as severe due to the presentation of moderate-to-diffuse corneal staining and symptomatic. To assess if there is a correlation between punctum size and the severity of DED, the Spearman's rank correlation coefficient was calculated. Of the 200 Level 2 and above eyes, 131 (66%) eyes had a large punctum ($\geq$0.5 mm). Punctum size larger than 0.4 mm was 95%. The estimated Spearman's ρ was 0.16. This indicates a statistical significant positive correlation ($P = 0.02$) between larger punctum size and higher level of DED. The larger size of lacrimal punctum may link to the severity of DED. Punctum inspection may be adopted to become one parameter for DED evaluation for practitioners.

Keywords:

Collagen punctum plug, dry eye disease, lacrimal system, punctum size, tear, tear duct

Introduction

Dry eye disease (DED) is a common and complex condition affecting roughly 5% and 34% of the world's population.[1-4] The differences in prevalence are largely due to variations in geographical populations, age, and variations in study. The etiologies of DED are wide and can stem from autoimmune disorders, age, prolonged concentration on computer screens, and even psychiatric disorders such as anxiety and depression.[1-4]

DED can be a result of the disturbance of the anatomy and/or physiology of the regularly functioning tear system. When the delicate balance between tear production and tear evaporation is disturbed, one may experience a gamut of symptoms such as visual discomfort, disturbance, pain, redness, burning, stinging, and others.[5-7] The classification of aqueous-deficient and hyperevaporative DED is useful in guiding clinical decision-making, but both may coexist in the clinical setting and thus an understanding of the functional unit of the tear production and collection system is needed.

Dry eye is a condition in which the surface of the eye is inadequately lubricated by tears due to insufficient quantity or quality of the tear from lacrimal gland and meibomian gland. As the eye blinks, the tear flows across the surface of the cornea and lubricates the eye and drains through the two puncta to the nose, promoting the health, vision, and integrity of the eye. The tears contain a complex mixture of fatty oils, proteins, water, and mucus.

The ocular surface (cornea, conjunctiva, and accessory lacrimal glands), meibomian

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glands (sebaceous glands of the eyelid margin), the main lacrimal glands, and the innervation between them are the basis of the tear system functional unit.[5] If any of these structures and their associated functions are suboptimal, the eye may become dry and experience damage and cause symptoms of DED. Thus, a number of mechanisms can be implicated in the pathogenesis as well as treatment of DED: chronic inflammation of the conjunctiva, diseased ocular surface and sensitivity, tear film impairment, and epithelial damage.[6-10]

Tears, the main constituent of DED, serve a multitude of functions such as lubrication, antimicrobial properties, anti-inflammatory properties, and delivery of nutrients to the surface of the eye. Tears are comprised of proteins (mucins, enzymes, glycoproteins, immunoglobulins, etc.), lipids, electrolytes, water, and organic solutes. The aqueous layer of the tear film contains predominantly proteins, water, and electrolytes while the outermost oily layer contains several classes of lipids (wax esters, triglycerides, free fatty acids, and polar lipids) and neutral diesters and the inner-most mucin (glycoproteins) layer contains mucin types that are considered to be secreted or membrane associated.[11] Without treatment, the late level of DED such as Level 3–4 can cause conjunctival scarring, ulceration, and even corneal perforation. These manifestations of DED prove to be challenging to manage during everyday life and can impact work productivity as well as the ability to do simple tasks such as driving.[12-15]

The lacrimal punctum is the opening port for the tear duct. Tears pass through the punctum to tear duct and to nasal cavity. The hypothesis is if the punctum is normal without swelling, the larger size should drain tears out more easily and causing more severe DED.

Currently, there are many methods to diagnose DED: slit-lamp examinations of the ocular surface, including staining, tear breaking time, TearLab to assess osmolarity, Quidel to assess the inflammatory marker matrix metalloproteinase-9, meibography, and topography. However, as punctum is importantly related to DED, punctum size inspection is not listed in the Dry Eye WorkShop 1 (DEWS1) or any educational papers for DED evaluation.

The aim of this study is to investigate if larger punctum size links to severity of DED. Perhaps, punctum inspection can be adopted to become one of the DED evaluations for practitioners.

Methods

This study has been approved by the Institutional Review Committee of University of Hawaii. The medical records of 200 eyes of 114 patients who underwent treatment for DED at Dr. Ming Chen's practice in Honolulu, Hawaii, from January 1, 2017, through July 31, 2018, were reviewed. Out of 114 patients, 80 (70.18%) of them were female, and the mean age was 70.30 years with a standard deviation of 10.48.

These 200 eyes included in the study were Level 2 or above according to the DEWS1 classification[3] and were all indicated for therapeutic punctum plug insertion due to nonresponse to drops (artificial tear, Restasis, Xiidra, etc.), omega-3, artificial tear ointment in addition to poor compliance, and financial reasons for the cost of medications. Punctal occlusion, an emerging modality for the rapid and efficacious therapy for DED, has been noted to improve the clinical symptomatology of DED.[16,17]

According to the DEWS1 classification,[3-17] eyes that had mild/moderate punctate staining on cornea with symptoms were classified as Level 2 while corneas that had diffuse cornea staining and more symptomatic were classified Level 3 and above in this study. The exclusion criteria were data with unknown or unable for DEWS scoring such as corneal opacity and ulcer. Unusual locations of punctum such as entropion or ectropion were all excluded. Eyes with contraindication for punctum plug were also excluded such as preexisting infection. Four eyes were excluded from the study according to the criteria. Of the 114 patients, some patients had one eye in the study; some had two eyes in the study based on the inclusion and exclusion criteria. Lacrimal punctum size of those eyes was approximately estimated according to the size of vertical canalicular soft collagen plug (from 0.3 to 0.5 mm diameter, Oasis, Lacrimedics, Glendora, CA, USA) to be inserted [Figure 1]. The size of the plug that was nonforcefully inserted into the punctum without dilation was designated as the size of the punctum [Figure 1].

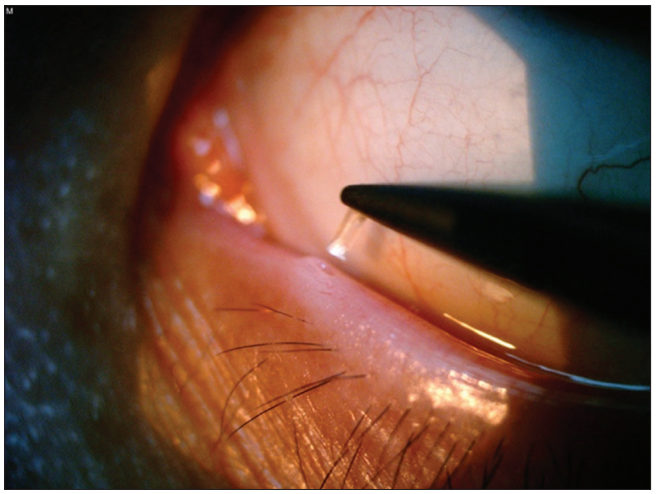

Figure 1: Approximation of punctum size with collagen plug

We followed the DEWS1 classification for the severity level of DED for this study. Spearman's rank correlation was used to estimate the correlation between the size of punctum and the severity level of DED. The Spearman's rank correlation coefficient is a nonparametric measure. The raw values were used to calculate the correlation coefficient. All 200 pairs of data were computed. Each eye's data had a corresponding set of values for the punctum size (0.3, 0.4, or 0.5) and the DED severity level (2, 3, or 4).

Results

All 200 eyes in this cohort were indicated and treated with the therapeutic collagen punctum plug insertion due to the severity of dry eye (level 2 to level 4) and poor response to medical treatments.

There were 11 eyes had to treat with 0.3 mm collagen plug (5%). 8 eyes were diagnosed as level 2 dry eye, 3 eyes were diagnosed as level 3. The Severity Level of dry eyes was classified according to DEWS1 classification 3.

There were 56 eyes had to treat with 0.4mm collagen plug (28%). 44 eyes were diagnosed as level 2 dry eye, 9 eyes were diagnosed level 3 and 3 eyes had level 4 dry eye.

There were 133 eyes had to treat with 0.5mm collagen plug (67%) in this cohort. 80 eyes were diagnosed as level 2, 46 eyes as level 3 and 7 eyes as level 4 [Table 1]. The data showed there were more 0.5 mm punctum size eyes in the cohort (67%). The statistical data showed positive correlation between large punctum sizes and severity level of DED in this cohort.

The estimated Spearman's ρ was 0.1617 with $P = 0.0222$. This indicated a positive correlation between large punctum size and severe level of DED in this cohort.

Discussion

We believe this is the first study on the larger punctum size linked to the severity of DED. Even in the DEWS1, punctum size was not listed for the classification of the level of DED.[3] Despite all various factors causing DED either aqueous deficiency or evaporation, the larger and patent punctum can drain more tears out of eye and into nasolacrimal system, further worsening DED.[1] As dry eye is a multifactorial disease of the tears and ocular surface, multiple diagnostic equipment and methods have been developed with much higher cost.[5]

Table 1: Correlation between punctum size and dry eye disease severity

Punctum plug size (mm)	Severity level of DED (%)			
	2	3	4	Total
0.3	8 (72.72)	3 (27.27)	0	11 (100)
0.4	44 (78.57)	9 (16.07)	3 (5.35)	56 (100)
0.5	80 (60.61)	46 (34.59)	7 (4.26)	133 (100)
Total	132	58	10	200

DED=Dry eye disease

There are other methods to measure punctum size in the literature: Carter *et al*. reported a computerized measurement using a computer cursor assembly probe to make measurements directly from punctal photography.[18] More recently, Balaram *et al*. described the use of a punctal gauging system (Eagle Vision, Inc., Memphis, Tennessee) to determine the appropriate plug size. 95% of this cohort had 0.4mm or large punctum who suffered from level 2 to 4 severity of symptomatic DED. In contrast, the Carter's study on normal asymptomatic cohort revealed wide variation of punctum size.[18] As to measure the exact size of the punctum using punctal photography and the punctal gauging system are expensive and unpractical in the clinic, we choose the approximated size of a temporary collagen plug to reasonably estimate the punctum size. It is economical, simple, and repeatable. As the size of an appropriate temporary punctal plug can act as a surrogate marker for punctum size during the treatment under a slit lamp, clinicians can perform diagnosis as well as treatment for DED. The result of this study may promote examination of the punctum size as one of the DED evaluation parameters.

A few limitations in this study exist. First, the study was a retrospective chart review and thus unrecognized confounding variables may impact the underlying findings. Second, the generalizability of this study is limited since the study was performed in a single private clinic. Finally, despite the statistically significant positive correlation coefficient, it was small in its sample size and the clinical significance must be further evaluated. Nevertheless, this study provides evidence to support a prospective randomized multicenter trial to further elucidate the link between larger punctum size and the severity of DED.

Conclusion

The larger size of lacrimal punctum may link to the more severity of DED. The size of an appropriate temporary punctal plug during treatment can act as a surrogate marker for punctum size. Physicians may benefit from evaluating punctum size routinely to plan the management for their DED patients.

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Conflicts of interest
The authors declare that there are no conflicts of interests of this paper.

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