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Review Article

Is the Generic Approach of Fitting Contact Lens Leading to Drop-outs? Role of Gender and Age in Ocular Surface Equilibrium

TonmoyChottopadhyay*, Hardeep Kaur, Aniket Saha, Amit J Shinde and Rupam Sinha

Assistant Professor, Department of Optometry, Bharati Vidyapeeth (DU) Medical College, Pune, India

***Corresponding Author:** Chottopadhyay T, Assistant Professor, Department of Optometry, Bharati Vidyapeeth (DU) Medical College, Pune, India

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Abstract

Objective: To identify and synthesize evidence about ocular surface changes during the differentphases of the menstrual cycle in women and to analyze the need for a gender-specific contact lens.

Methods: Studies, included in the review were targeted interventions towards the women population conducted in developing and developed countries related to the current research objective. 4 databases were searched for articles published in English and other languages between January 1990 and December 2016.

Results: Seventeen studies out of 166 total studies that met the inclusion criteria had positive results. Literature shows a high dependency on the ocular surface on gonadocorticoids. It stated that the frequent hormonal changes in women during the menstrual cycle also altered the overall ocular surface, especially the tear film physiology.

Conclusion: This review provides evidence that during the different phases of the menstrual cycle a cyclic and random changes take place in the ocular surface resulting in more incidence of dry in women which may lead to change in contact lens comfort and tolerance level. Hence questioning the use of a single contact lens throughout the phase and justify the need for a gender-specific contact lens.

Keywords: Menstruation related ocular changes; Hormone-related ocular changes; Dry eye in women; Contact lens;Gonadocorticoids

Introduction

The human genome consists of 23 pairs of chromosomes (a total of 46). One set of 23 comes from the mother and one set comes from the father. Of these 23 pairs of chromosomes, 22 are autosomes, and one is a sex chromosome. An autosome is a chromosome that is chiefly associated with the metabolism or metabolic function of the child, whereas the sex chromosome determines the gender of the baby. There are two kinds of sex chromosomes–"X" and "Y". In humans and in almost all other mammals, females carry two X chromosomes, designated XX and males carry one X and one Y, designated XY.

The reproductive systems of the male and female have some basic similarities and some specialized differences. They are the same in that most of the reproductive organs of both sexes develop from similar embryonic tissue, meaning they are homologous. Both systems experience maturation of their reproductive organs, which become functional during puberty as a result of the gonads secreting sex hormones. The most obvious differences between the female and male reproductive systems are basically based on the functions of their role in the reproductive cycle, notably the endocrine system and their physiological and behavioral effects, including the gonoidal differentiation, internal and external genital differentiation and the differentiation of muscle mass, height, and hair distribution, which has been proved numerous times[1]. But recent studies also report that the nature of the ocular surface is not only different but also highly diverse between the male and female population [2]. They considered the difference in the endocrine system and its secretion as the main reason for this diversity and also the menstrual cycle which result in a higher rate of instability of the ocular surface in women compared to men [3]. Men produce a higher quantity of testosterone and a very small amount of estrogen and progesterone whereas the women produce a very small amount of testosterone and a high amount of estrogen and progesterone. Not only this but also the hormonal levels in women have been found to be highly dynamic compared to men i.e. the level of hormones in the blood varies on a regular basis [4].

For instance, in the initial 14 days of the menstrual cycle also called the follicular phase there is a rapid increase in the level of the hormone estrogen in the blood seen after 6th day i.e. just after the menstrual flow ceases. During this phase, there is also an increase in the level of progesterone, the hormone estrogen reaches its maximum level on the 13th day i.e. just before the ovulatory phase and ovulation. During the ovulation, there is an increase in the level of testosterone in the blood. After the ovulatory phase is complete there is an increase in the level of progesterone and estrogen in the blood but contrary to the proliferative phase: here the progesterone hormone level is much higher compared to estrogen which again lowers down towards the end of the 28-day(averagely) menstrual cycle [4,5].

This fluctuation leads to a periodical and repetitive cyclic change in the ocular environment and its different structures hence destabilizing the overall ocular surface especially the tear film which is found to be the most affected.The tear film is the outermost layer and mostly consists of water which is sandwiched between a lipid layer in outside towards the atmosphere and a mucosal layer on the inside. The watery layer also is known as the aqueous layer secreted by the lacrimal gland presents superior-lateral to the eye. The lipid layer is secreted by the meibomian glands present in the inner margin of the eyelids, this layer cuts-off contact between air and aqueous layer and hence, decrease the rate of evaporation of water [6]. The ocular surface is a hydrophobic layer hence the mucin layer converts this into a hydrophilic layer. The mucin layer is the innermost layer which is secreted by the goblet cells, situated in the conjunctiva. This hydrophilic layer helps to hold the tear film in its place and keeps the eye moist [7].

The eye is a fascinating organ and may be called the mother of all sense organs in the body, hence it requires utmost care possible. This care is provided by the eyelids and tear film. The eyelids act as a protective cover whereas the tear film has varied roles such as maintaining a moist environment on the surface of the eye, preventing the epithelial cells from becoming dry and damaged, also lubricating the surface of the eye hence facilitating the movement of the eyelids over the eyes smoothly. It maintains a smooth refracting surface on the cornea, to ensure that the eye can see clearly. The cornea helps in bending the light rays and making a focus over the retina, the photographic plate of the eye if we compare the eye with a camera. Tear film also provides the cornea with the nutrients and oxygen necessary for its metabolism as the cornea has no blood vessels. The tear film contains enzymes (such as lysozyme), antibodies, and phagocytic cells that destroy bacteria and prevent the growth of microcysts of the cornea. The tear film also helps to remove waste products from the cornea and eliminates foreign bodies from the surface of the eye by blinking as well as helps in adjusting to temperature changes. The tear film also facilitates contact lens wearing and plays an important role in lens stabilization (especially the toric contact lenses).

The contact lens is an optico-medical device that is placed directly on the surface of the eye. When the lights fail to make a clear image over the retina contact lenses can help further to improve visual clarity and/or to improve the cosmetic appeal of the person. The better the tear film quality the better will be the lens stability and hence better will be the vision and comfort.

This review was aimed to get an idea about how the ocular surface of women differs from the men and how it changes throughout the menstrual cycle causing instability.

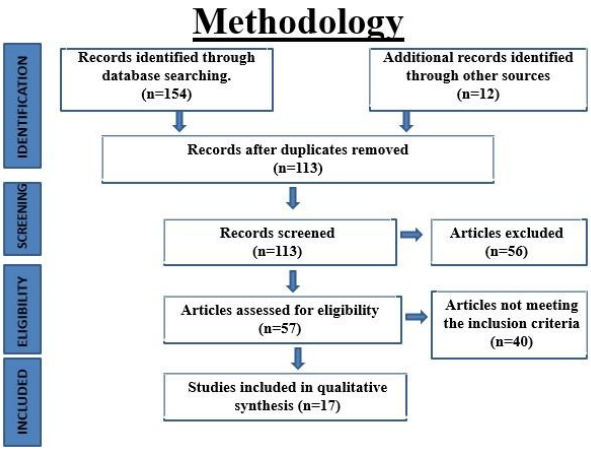
Materials and methods

Inclusion criteria: The included studies targeted interventions towards the female population giving a relevant answer to the research question and were conducted either in developing or developed countries. The inclusion criterion was set and relevant studies that answered the research question were taken. To be included, the studies had to be at least 6 months' observational study, proper clinical trials, case reports, or survey in the form of questionnaires with clearly stated methodology. Articles were analyzed in the English language and the articles which were in other languages were converted to English.

Search strategy:

As per the pre-decided inclusion criteria, the database was searched using the keywords menstruation-related ocular changes, hormone-related ocular changes, dry eye in women and relevant studies were sorted out.

Figure 1. Methodology.



166 studies were identified from electronic databases including Medline, PubMed, Google Scholar, and Healthstar published between January 1990 and December 2016. The references of the reviewed articles and included original publications were also screened for potentially relevant studies.

Data analysis

Due to the heterogeneity of populations, interventions and outcomes, it was not possible to combine outcomes in a meta-analysis and hence only study narratives were taken.

Results

The initial search identified a total of 5217 citations. After scanning titles of the citations, 615 were accepted for further screening and complete abstracts of these studies were reviewed. Of these, 166 citations were identified as potentially meeting the inclusion criteria. After examination of full-text articles, 17 studies were included in the review. The studies were categorized under two main aspects. 1) The first (total number of studies 14) was of those studies dealt with physiological changes in women due to the menstrual cycle. This was further subdivided into two groups: a) the overall ocular manifestation of the menstrual cycle. (Table 1-a) studies were grouped here and conclude that the ocular surface undergoes rapid changes during the menstrual cycle. Changes were recorded in the corneal thickness and the ocular surface equilibrium. It was reported that the ocular surface was in its poorest condition (dryness of the ocular surface) on day 21 of the menstrual cycle and the cornea was thickest during ovulation [8-9].

Table 1-a: Menstrual cycle related ocular changes.

Liberati V, et al. 2002 [8]	The level of Lacrimal fluid peroxidase (which protects oxidative damage to ocular surface) changes throughout the menstrual cycle.
	Lacrimal fluid peroxidase activity is regulated by estrogen.
Giuffre G, et al. 2007 [10]	The cornea is thinnest at the beginning of the cycle and thickest at the end.
	Estrogen receptors are found in human cornea.
P Versura, et al. 2007 [11]	Dry eye symptoms were significantly higher during the peak of estrogen production.
Yakov Goldich, et al. 2011[12]	The corneal hysteresis and the corneal resistance factor were temporarily decreased at ovulation. The cornea was thinnest at the beginning thicker at ovulation and at the end of the cycle.
Cavadar E, et al. 2014 [13]	Fluctuations in the blood level of estrogen produce alteration in ocular surface equilibrium during the menstrual cycle and consequently affect the subjective dry eye symptoms in the female patients.
	For the female patients the ocular surface was poorer on day 21 than in day 2 or day 12.
Negar Amiri Ghanfarokhi, et al. 2015	Thickest cornea during the ovulation and thinnest at the end of the cycle.

And, b) how the hormonal imbalance affects the ocular environment. Here remaining 8 (Table 1-b) studies were grouped. They concluded that changes in ocular environments were mainly due to the change in the hormonal levels. It was noticed that with the decrease in the level of testosterone in the blood there was more incidence of meibomian gland dropout and decreased lipid secretion [3,14-16] and many studies conclude that lower level of estrogen trigger both lacrimal gland apoptosis and necrosis hence decreasing the lacrimal tear production [17-20]. It's also a fact that during the menstrual cycle these hormonal levels were never constant and changed regularly.

The second aspect included those studies which dealt with the consequences of such ocular surface imbalance. There are 3 (Table 2) studies under this category that say that the fluctuation in the level of hormones in women resulted in more incidences of dry eye mainly due to decreased lipid secretions.

Table 1-b: Influence of gonadocorticoid hormones on ocular surface.

Kathleen l. krenzer, et al. 2000[21]	Patients taking antiandrogen therapy, compared with controls, had significant changes in their meibomian glands, including orifice metaplasia, reduced quality of secretions, a striking alteration in the neutral lipid profile of secretions and a morphological appearance consistent with severe disease.
Liberati V defeo G et al. 2002 [8]	The level of Lacrimal fluid peroxidase (which protects oxidative damage to the ocular surface) changes throughout the menstrual cycle.
	Lacrimal fluid peroxidase activity is regulated by estrogen.
Susan Truong et al. 2014[14]	Androgens enhance meibomian gland function and the quality and quantity of meibomian gland lipid.
	Estrogen and progesterone suppress the sebaceous gland and reduce lipid production.

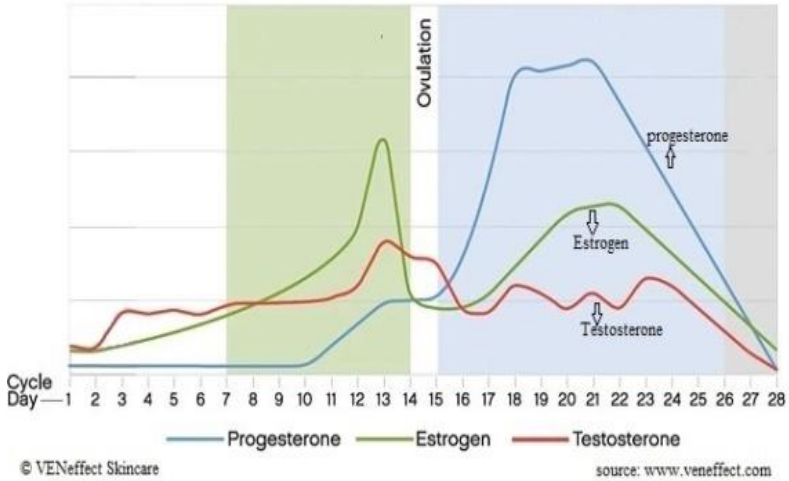
Table 2: Women and dry eye.

Sagili Chandrasekhara Reddy, et al. 2016 [24]	Symptoms of dryness are more frequent in contact lens wearers and increased with increasing age.
Markoulli M, Kolanu S 2016 [25]	Dryness and discomfort are the main reason for dropout.
RodiahRahmaWatylubis, Monica Tumiar 2018 [26]	Dry eye is not related to lens wear duration but is affected by contact lens material, lens care solution, eye drop usage and the environment.

Discussion and Conclusion

During the menstrual cycle, there is mainly an alteration of the lipid layer hence inducing dryness in the person's eye. Other than this, changes were also recorded in the corneal thickness, corneal hysteresis, corneal sensitivity, and the ocular surface equilibrium [11-12,27-29]. It was reported that the ocular surface was in its poorest condition on day 21 of the menstrual cycle [13].If the hormonal level is plotted on a graph (Figure 2) it can be seen that on day 21 and 22 of the menstrual cycle the level of estrogen and progesterone in the blood is very high compared to testosterone which can be one of the main reasons of the poorer ocular condition on these days. A periodical alteration in the overall corneal thickness was also reported in the studies. It was seen that the corneal thickness wasmaximum during the ovulatory phase [9, 10].

Figure 2: Change in hormonal levels throughout the menstrual cycle (used withthe permission of Veneffect Skincare and Dr. Rebecca Booth).



This kind of change was not found in men, mostly due to the relative stability of the hormonal level which only declined with age in a regressive manner [30]. The change in estrogen level with age was found to be abrupt in women. The secretion of the meibomian glands and goblet cells is very much crucial for tear film stability. A lesser amount of testosterone and a higher amount of estrogen cumulatively result in lesser lipid and mucin secretion [14]. All these changes in the hormonal level throughout the menstrual cycle lead to dry eyes and discomfort [31]. This is also a global phenomenon as studies done in various countries have reported almost twice the number of female dry eye patients compared to men [31-32].

Studies also suggest that the prevalence and incidence rates of primary open-angle glaucoma are higher in women compared to men [33]. Further study is required to establish whether it is related to the menstrual cycle influenced by changes in corneal hysteresis.

The majority of the contact lens users are the younger female population. Clinical practitioners report that women are much more eager to use contact lenses than men[34-37]. At the same time practitioners report that women contact lens wearer complaints more of sensations such as irritation, watering, redness, and dryness[38-39]. Discomfort and dry eyes are the two major factors of contact lens

wear leading to limitations in the duration and period of wear. Subsequently resulting in contact lens dropout. Not only the majority of contact lens users, as per the mathematical probability, but women may also be the majority of the dropouts as well [40]. Parallel to the mathematical probability of dropout, this review gives some insight regarding the hormonal changes throughout the menstrual cycle and related ocular equilibrium changes. Which can theoretically explain the women's contact lens drop out; not only for the younger women but also for the pre-menopausal group (abrupt changes in estrogen level). Although rigorous clinical supports are very necessary to clearly understand the relationship between contact lens drop out and menstrual ocular instability, but maybe it is high time to start considering menstrual physiology as an important aspect while manufacturing and dispensing contact lenses especially in the case of women. Because firstly women form the majority of contact lens users and also one thing that can be understood from this review is that the ocular environment, the basis on which contact lenses are manufactured varies dynamically, which calls for something apart from the presently available modalities of contact lenses. Hence, a gender-specific product is required, which would match the unique need of the ocular environment, especially of that of women.

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