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Original Research Article

A retrospective study: impact of various phases of menstrual cycle on corneal pachymetry

Aneesha Kardam Vyas[1,*], Poonam Rana[2], R N Kothari[1], Zeel Patel[1], Avani Soni[1]

[1] *Dept. of Ophthalmology, Dhiraj Hospital, SBKS MI&RC, Sumandeep Vidyapeeth, Piparia, Vadodara, Gujarat, India*
[2] *Dept. of Ophthalmology, Supreme Hospital, Noida, Uttar Pradesh, India*

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ABSTRACT

Aim: To evaluate the effect of the various phases of menstrual cycle on corneal pachymetry.
Materials and Methods: 100 female participants were selected retrospectively, who underwent a through screening and ophthalmic evaluation. Corneal pachymetry was measured using an ultrasound pachymeter. Readings of both the eyes were taken on day 1-3, day 13-15 and day 26-28 of the menstrual cycle. An intergroup comparison was carried out and statistical significance was found.
Results: It was found that the corneal thickness was at its thickest i.e. 547.51± 31.824 on day 13-15 which coincides with ovulation and thinnest i.e. 548.25± 29.948on day 1-3 of the menstrual cycle ($p<0.000$).
Conclusion: All in all, we conclude that hormonal changes do affect the ocular structures in a profound manner. In view of the cornea, they have a role in disturbing the pump mechanism of corneal endothelium, especially when oestrogen levels are at their highest. This eventually leads to a physiological increase in corneal thickness due to corneal edema and having an indirect effect on visual acuity and corneal sensitivity and intraocular measurement.

1. Introduction

The cornea is a deemed to be the window to the eye. This avascular, transparent, membrane like prolate shaped structure is one of the most vital parts of the human eye.[1] As the body ages, structural and morphological changes have been appreciated. An adult corneal diameter measures 11-12mm horizontally and 9-11mm vertically. Central corneal thickness is about 0.5-0.6mm and can go up to 1mm at the periphery. The radius of curvature is more anteriorly than posteriorly which makes this an aspheric system. The total refractive index of the cornea is 1.376. Nutrition to the cornea is derived from the atmospheric air, tears, perilimbal vessels and the aqueous humor. Glucose and amino acids are the main source of energy for the cornea. These properties of transparency, avascularity and being immunologically privileged makes it unique in itself.[2]

Anatomically 6 layers namely ; the epithelium, bowman's layer, stroma, pre-descemet, descemet layer and lastly the endothelium constitute the cornea. The endothelium is the site of active pumps which helps maintain the cornea in a dehydrated state. However, any pathological condition such as trauma can alter this status and result in corneal edema. Various physiological factors such as the alternation in the corneal thickness during the menstrual cycle have been speculated. Changes in the corneal thickness, sensitivity and curvature have been commented upon in literature.

Hormones such as oestrogen, progesterone, follicle stimulating hormone and luteinising hormone are predominantly present in a female. These are thus responsible for the menstrual cycle every 28 days. The menstrual cycle has 4 phases, menstruation, follicular phase, ovulation and the luteinising phase. It is known that the oestrogen and progesterone have a high lipid solubility and thus readily gain access in the cornea via the tear film or the

* *Corresponding author*.
E-mail address: aneevy@gmail.com (A. K. Vyas).

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aqueous humor. The corneal epithelium has receptors for oestrogen and progesterone.[3] The main action of oestrogen is on the corneal endothelium causing an imbalance of sodium and chloride eventually causing hydration and thus manifesting as corneal edema. This corneal edema thus corresponds to an increase in corneal thickness which is marked during ovulation (day 14 of themenstrual cycle) and early proliferative phase (day 16-18 of the menstrual cycle) citing oestrogen dominance.

Changes in intraocular pressure have also been documented due to progesterone dominance. It has been hypothesised that two spikes in the intraocular pressure have been observed, one at ovulation (day 14 of menstrual cycle) and the other towards the end of the cycle (day 22-24 of the menstrual cycle).

Apart from the cornea, the fluctuating hormones seems to have an effect on meibomian glands, tear film, conjunctival epitheli um, lens and the retina.[4] Hence these changes have been more pronounced in a long term presentation such as pregnancy.[5]

All of these factors eventually contribute to visual disturbance. The fluctuating corneal parameters can be recorded and would also prove to be useful in screening criteria the cases for refractive procedures such as laser assisted in situ keratomileusis (lasik), photorefractive keratectomy (prk,)etc, and rule out a possible risk of future ectasia.

Very few studies have pondered on this physiological aspect and our study emphasises on the changes in the central corneal thickness during the various phases of menstrual cycle.

2. Materials and Methods

The study was conducted in the department of ophthalmology, Dhiraj hospital, SBKS MI&RC, Piparia, Vadodara, Gujarat from May 2016 to September 2017 under the declaration of tenets of Helsinki. 100 female participants aged between 13-55 years were included in the study and data was calculated retrospectively. Any patient with a pre-existing gynaecological condition, hormonal drugs, oral contraceptives and associated systemic illness such as diabetes, liver cirrhosis were excluded along with those on prolonged contact lens use, corneal scars, ectasia's, trauma, and active infections such as adenoviral keratoconjunctivitis, herpes simplex keratitis etc. Detailed ophthalmological and gynaecological history including past history was noted. Visual acuity was assessed using Snellen's chart. Ophthalmological evaluation was done using slit lamp and fundus evaluation with an indirect ophthalmoscope. Intraocular pressure was measured using a Goldmann applanation tonometer and corneal thickness using an ultrasonic pachymeter on day 1-3, day 13-15, day 26-28 of the menstrual cycle.

2.1. *Statistical analysis*

All the results are expressed as the number, percentages and mean ± standard deviation (SD). The comparison of continuous variables between the groups was performed by the Z test and Bonferroni's analysis. P value of <0.05 was considered significant. Results out of 100 participants, 52% had an average of 5 day duration of menstruation in the cycle. Pachymetry in the right eye was 533.24±29.444 (day 1-3), 547.51± 31.824 (day 13-15) and 537.22± 29.629 (day 26-28), (p value-0.000). Paired wise comparison of all the three groups showed a standard error of 2.33 which was significant. Similar findings were seen in the left eye readings. Pachymetry was 534.49±30.087 (day 1-3), 548.25± 29.948(day 13-15) and 538.28± 29.972(day 26-28), (p vaue-0.000). Paired wise comparison of all the three groups showed a standard error of 2.115 which was significant. The central corneal thickness of the right eye was thickest at ovulation (day 13-15) and thinnest at the menstruating phase (day 1-3) (As shown in Figure 1).

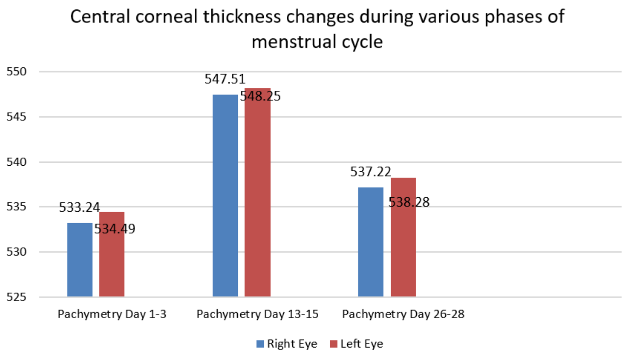

Fig. 1: Denotes the variation in pachymetry measured atdifferent phases of menstrual cycle

3. Discussion

The central corneal thickness changes under the influence of fluctuating hormonal levels during the menstrual cycle as hypothesised in literature. It is well established that the corneal pachymetry is thickest during ovulation and thinnest on the initial days of the menstrual cycle.[6] The steroid sex hormones, predominantly oestrogen seems to affect the endothelial pumps. Thus at the peak of oestrogen activity which corresponds to ovulation phase of the menstrual cycle there is an increase in the central corneal thickness.[7]

Goldich et al, studied 22 women of mean age 19.5±1.5years and noticed that the central cornea was thinnest at the beginning 534 microns and statistically significant at ovulation 542 microns ($p<0.001$) and 543microns at the end of ovulation ($p<0.001$).[8]

Giuffre et al, in a study on 16 women, had similar findings in terms of corneal thickness and its association with various phases of menstrual cycle. The statistical difference was significant with values at ovulation ($p<0.003$) and end of cycle ($p<0.001$) compared with values with at the beginning of the cycle.[9]

However Feldman et al, on their studies on 11 women found that the cornea was relatively the thinnest at the time of ovulation which was a stark contrast to the popular finding. Yet, majority of the studies done show a consensus of thickest corneal pachymetry at time of ovulation.[10]

In our study, values were 533.5 microns at day 1-3 of the cycle, 547 microns at ovulation and 537 microns at day 26-28 ($p<0.005$). Our study is the first to have an adequate sample size. Pachymetry is an essential screening and diagnostic parameter for all patients undergoing refractive surgery evaluation (lasik, prk, etc.). Knowing this information helps us to rule out the borderline cases with fluctuating thickness and thus prevent sight threatening complication of ectasia. Also, we hope that the difference in the thickest and thinnest pachymetry might help in the understanding of glaucoma. Falsely thicker corneas can be known and a corrected baseline value can be established.

4. Conclusion

Central corneal thickness behaves in accordance to hormonal influences, especially oestrogen. In our study an adequate sample size of 100 female participants was taken and it was observed that the cornea was thickest at ovulation and thinnest at day1-3 of the menstrual cycle. This factor should be considered while evaluating and screening the patient for refractive surgery work up and thus aid in preventing any potential ectasia's. Further more various other ocular disturbances have been documented in literature due to fluctuating hormone levels. An even larger sample size and biochemically quantifying the hormone levels can be done in future to gain a deeper understanding.

5. Conflict of Interest

None.

6. Source of Funding

None.

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Author biography

Aneesha Kardam Vyas 3rd Year Post Graduate Resident

Poonam Rana Consultant

R N Kothari Professor and HOD

Zeel Patel 3rd Year Post Graduate Resident

Avani Soni 3rd Year Post Graduate Resident

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