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EVALUATION OF CORNEAL TOMOGRAPHIC CHANGES DURING PREGNANCY

By

Ahmed Abo El-Soud, Mohamed Khedr and Hatem Mahmoud

Department of Ophthalmology, Faculty of Medicine, Al-Azhar University

Corresponding author: Ahmed Abo El-Soud, **E-mail:** ahmedaboelsoud906@gmail.com

ABSTRACT

Background: The majority of alterations in the ocular system arise from metabolic, hormonal, and immunologic changes provoked by pregnancy. Some of these alterations might contribute to the initiation of new ocular conditions, and others may result in exaggeration, resolution, or improvement of previously established conditions. These effects occur mostly due to the interaction of estrogen and progesterone with their counterpart receptors in eye tissues.

Objective: To evaluate corneal tomographic changes during pregnancy and after delivery.

Patients and methods: This was a prospective study that included 20 eyes of 10 pregnant female subjects. All subjects underwent complete ophthalmic examination including visual acuity assessment, slit-lamp biomicroscopy, intraocular pressure measurement, fundus examination, and corneal tomography using Sirius tomography (CSO, Italy) at Kafr El-Sheikh Ophthalmology Hospital during the period from October 2020 to March 2021.

Results: There were statistically significant UCVA changes between pre-partum (0.720 ± 0.167) and post-partum (0.770 ± 0.130) conditions. There were statistically significant corrected distance visual acuity (CDVA) changes between pre-partum (0.930± 0.092) and post-partum (0.980 ± 0.052). There statistically significant IOP changes between pre-partum (15.750 ± 2.403) and post-partum (18.250 ± 2.074) condition. There were statistically significant K2 changes between pre partum (44.556± 1.416) and post-partum (44.024 ± 1.718) conditions. There were statistically significant average K changes between pre-partum (44.178±1.409) and post-partum (43.732±1.682) conditions. There were statistically significant anterior chamber depth changes between pre partum (3.118 ± 0.358) and post-partum (2.999 ± 0.255) conditions. However, there were no statistically significant changes in K1, K Max, TCT, CCT, AE, PE and ACA from pre-partum to post-partum conditions.

Conclusion: No refractive surgery procedures performed during pregnancy till at least three months after delivery, because of the variability of the refractive state of the eye during this period.

Keywords: Corneal tomography, Pregnancy, Sirius system.

INTRODUCTION

The cornea is a transparent avascular connective tissue that acts as the primary infectious and structural barrier of the eye. Together with the overlying tear film, it also provides a proper anterior refractive surface for the eye. Its clarity is the result of many factors including the structural anatomy and physiology of its cellular components *(DelMonte and Kim, 2011)*.

During pregnancy, there are various physiological changes affecting most of the female body organs. Of these physiological changes that is occurring in the eye. There is a change in refractive status of the eye as a result of hydration of

the cornea as well as corneal tomographic changes *(Mackensen et al., 2014)*.

Corneal tomography represented a true revolution in the diagnosis and management of corneal disease. One of the most important applications of corneal tomography is evaluation of subject's candidate for laser corneal refractive surgery *(Ambrósio et al., 2010* and *Wilson & Ambrósio, 2010)*. Corneal tomography has been found to be sensitive for detecting subtle changes in the cornea secondary to ectatic disorders prior to loss of corrected distance visual acuity and the development of typical slit-lamp microscopy findings *(Maeda et al., 2010)*.

The SIRIUS is a high resolution rotating Scheimpflug camera system that is used to analyze tomographic measurements of the cornea together with lens densitometry. Its rotating Scheimpflug camera quickly generates a series of images to create a three-dimensional (3D) model of the anterior chamber *(Magalhaes et al., 2011* and *Rabsilber et al., 2012)*.

The aim of our study was to evaluate corneal tomographic changes during pregnancy and after delivery using the Sirius corneal tomography.

PATIENTS AND METHODS

This was a prospective study that included 20 eyes of 10 pregnant female subjects. All subjects underwent complete ophthalmic examination, including visual acuity assessment, slit-lamp biomicroscopy, intraocular pressure measurement, fundus examination, and corneal tomography at Kafr El-Sheikh Ophthalmology Hospital during the period from October 2020 to March 2021.

Inclusion Criteria: Age from 19 to 34 years old, normal pregnancy without complication, pregnant woman without chronic disease as DM and HTN, physiological birth or cesarean section, and good cooperation during research.

Exclusion criteria: Previous ocular surgery, corneal scars or opacities, previous history of corneal ulcers, patients with any associated corneal or eye lid diseases, chronic use of topical medications, systemic collagen diseases, e.g. Marfan, Ehler Danlos syndromes, contact lens wearing, and lack of cooperation during research.

After receiving the approval of our faculty ethical committee, all patients received a thorough explanation of the study design and aim. The study was conducted in compliance with informed consent regulations.

All participants were subjected to:

History: A detailed history of any vision abnormalities noticed during pregnancy.

Examination:

1. Evaluation of the uncorrected and best-corrected distance visual acuity using Landolt's broken ring chart.
2. Manifest refraction using the autorefractometer.
3. Slit lamp biomicroscopy for examination of the anterior segment of the eye.
4. Pupillary examination.
5. Fundus examination: Dilated fundus examination using direct and indirect ophthalmoscopy
6. IOP measurement using Goldman applanation tonometery.

7. Corneal tomography using Sirius system (CSO, Florence, Italy).

Examination and corneal tomography have been carried out on the third trimester (the 8th month of gestation) and 3 months after delivery.

Study parameters included:

- Keratometry (k1, k2 and average K) and symmetry index front (SIF) that measures vertical asymmetry of anterior corneal curvature where negative values indicate steeper superior cornea and positive values indicate steeper inferior cornea, Apical keratometry front (AKF) that indicates the steepest point of anterior corneal surface, The Sirius system provides SIF and AKF to study the anterior corneal symmetry and curvature and to analyze how these values change after eyelid position modification.
- Pachymetry (central and thinnest corneal thickness).
- Anterior and posterior elevation measurements 4mm.
- Anterior chamber depth.
- Anterior chamber angle.

Statistical analysis:

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for the Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Wilk test. Quantitative data were expressed as mean ± SD (Standard deviation) and range. Independent samples t-test was used to compare between two independent groups of normally distributed variables (parametric data). P value < 0.05 was considered significant.

RESULTS

This was a prospective study that included 20 eyes of 10 subjects of pregnant female with age ranged from (19 - 34 years) **(Table 1)**.

Table (1): Demographic characteristics of studied cases

Descriptive Statistics						
	Range			Mean	±	SD
Age	19	-	34	26.000	±	4.899

The UCVA changed from (0.720 ± 0.167) pre-partum to (0.770 ± 0.130) post-partum, with statistically significant difference (P value =0.014).

The CDVA changed from (0.930±0.092) pre-partum to (0.980 ± 0.052) post-partum, with statistically significant difference (P value =0.002).

The IOP changed from (15.750 ± 2.403) pre-partum to (18.250 ± 2.074) post-partum, with statistically significant difference (P value <0.001).

The K1 changed from (43.846 ± 1.385) pre partum to (43.455 ± 1.682) post-partum, with no statistically significant difference (P value= 0.072).

The K2 changed from (44.556 ± 1.416) pre partum to (44.024 ±1.718) post-partum, with statistically significant difference (P value = 0.002).

The average K changed from (44.178± 1.409) pre partum to (43.732 ± 1.682) post-partum, with statistically significant difference (P value = 0.017).

The K Max changed from (46.462 ± 4.849) pre partum to (45.436 ± 1.646) post-partum, with no statistically significant difference (P value =0.349).

The central corneal thickness changed from (516.300 ± 44.239) pre-partum to (516.450 ± 43.782) post-partum, with no statistically significant difference (P value =0.970) **(Table 2)**.

Table (2): Changes in UCVA, CDVA, IOP, K1, K2, average K, K Max and central corneal thickness in pre and post-partum

Time	UCVA		Differences	P-value
	Range	Mean±SD	Mean±SD	
Pre-Partum	0.4-1	0.720±0.167	-0.050±0.083	0.014
Post-Partum	0.5-1	0.770±0.130		
	CDVA			
Pre-Partum	0.7-1	0.930±0.092	-0.050±0.061	0.002
Post-Partum	0.8-1	0.980±0.052		
	IOP			
Pre-Partum	12-21	15.750±2.403	-2.500±1.100	<0.001
Post-Partum	14-22	18.250±2.074		
	K1			
Pre-Partum	41.5-46.66	43.846±1.385	0.390±0.917	0.072
Post-Partum	41.07-46.67	43.455±1.682		
	K2			
Pre Partum	42.07-47.02	44.556±1.416	0.533±0.672	0.002
Post-Partum	41.21-47	44.024±1.718		
	Average K			
Pre-Partum	41.47-46.84	44.178±1.409	0.446±0.762	0.017
Post-Partum	41.3-46.83	43.732±1.682		
	K Max			
Pre-Partum	42.32-65.93	46.462±4.849	1.026±4.782	0.349
Post-Partum	42.2-48.54	45.436±1.646		
	Central corneal thickness			
Pre-Partum	456-590	516.300±44.239	-0.150±17.542	0.970
Post-Partum	448-567	516.450±43.782		

The thinnest location of corneal thickness changed from (512.950±43.542) pre partum to (512.600 ± 42.685) post-partum, with no statistically significant difference (P value =0.928).

The anterior elevation changed from (5.700 ± 1.625) pre-partum to (6.250 ± 1.832) post-partum, with no statistically significant difference (P value = 0.150).

The post elevation changed from (12.900 ± 3.127) pre partum to (12.850 ± 3.345) post-partum, with no statistically significant difference (P value = 0.958).

The anterior chamber depth changed from (3.118 ± 0.358) pre partum to (2.999 ± 0.255) post-partum, with statistically significant difference (P value =0.038).

The anterior chamber angle changed from (42.750 ± 7.718) pre partum to (42.050± 6.395) post-partum, with no statistically significant difference (P value = 0.602) **(Table 3)**.

Table (3): Changes in thinnest location of corneal thickness, anterior elevation, post elevation, anterior chamber depth and anterior chamber angle in pre-and-post-partum

Time	Thinnest corneal thickness		Differences	P-value
	Range	Mean±SD	Mean±SD	
Pre-Partum	454-585	512.950±43.542	0.350±17.002	0.928
Post-Partum	446-560	512.600±42.685		
	Anterior elevation			
Pre-Partum	3-9	5.700±1.625	-0.550±1.638	0.150
Post-Partum	2-9	6.250±1.832		
	Post. elevation			
Pre-Partum	8-19	12.900±3.127	0.050±4.199	0.958
Post-Partum	6-20	12.850±3.345		
	Anterior chamber depth			
Pre-Partum	2.45-3.71	3.118±0.358	0.119+0.238	0.038
Post-Partum	2.66-3.57	2.999±0.255		
	Anterior chamber angle			
Pre-Partum	29-58	42.750±7.718	0.700±5.904	0.602
Post-Partum	33-55	42.050±6.395		

DISCUSSION

In this study, we used Sirius corneal tomography that measured both anterior and posterior corneal surface by combining Scheimpflug tomography and Placido disc topography. This device gave information about the (K1, k2, K Max, central corneal thickness, thinnest location of corneal thickness, anterior elevation, post elevation, anterior chamber depth and anterior chamber angle).

In our study, there was no significant difference in corneal thickness (CCT, thinnest corneal thickness), K1 and K Max between pre-partum and post-partum women. There was a statistically significant change between pre-partum and post-partum in K2 and average K.

The present study matched with the publications by *Goldich et al. (2014)*, *Sen et al. (2014)*, and *Naderan and Jahanrad (2017)* who claimed that CCT does not change during pregnancy.

Goldich et al. (2014), obtained a statistically significant difference concerning only K2 parameter in pregnant

women (60 eyes) compared to non-pregnant women.

The present study disagreed with the study done by *Ataş et al. (2014)* who demonstrated significant differences in all three keratometric parameters (K1, K2, mean K) and central corneal thickness in the third trimester of pregnancy compared to the examination in the 3 months after delivery. *Efe et al. (2012)* conducted a study on a group of 25 women (50 eyes) following dynamic changes in CCT between the 10 weeks of pregnancy and the 3-months postpartum. They proved the presence of a significant thickening in the central part of cornea in the second and third trimesters of pregnancy, compared to the measurements carried out in the 3 months after delivery.

In our study, no significant difference in anterior elevation (AE) and posterior elevation (PE) between pre-partum and post-partum women was observed. Our study matched with the study done by *Naderan and Jahanrad (2017)* who revealed no statistically significant changes in anterior and posterior elevation measurements in pregnant women.

In our study, there was no significant difference in the anterior chamber angle between pre-partum and post-partum period. There was a statistically significant difference in the anterior chamber depth between pre-partum and post-partum period.

The present study agreed with the study done by *Ataş et al. (2014)* who conducted on a group of 54 healthy pregnant women and evaluated data during the third trimester and 3 months after delivery. They reported significant changes during pregnancy when compared to the postpartum period in anterior chamber depth, anterior chamber volume and anterior chamber angle.

Goldich et al. (2014) performed a comparative study between pregnant and non-pregnant women using topographic and biomechanical measurements. A Scheimpflug imaging device (Pentacam HR) assessed the topographic differences between the 2 groups, where no differences were observed in anterior chamber depth, anterior chamber volume and anterior chamber angle.

In the present study, there was an increase in post-partum values of UCVA and CDVA with a statistically significant change between pre-partum and post-partum period in UCVA and CDVA.

The present study agreed with the study done by *Garg and Aggarwal (2012)* who reported decrease in distance best corrected visual acuity during pregnancy. Decreased visual acuity for distance was also observed in a previous study by *Ebeigbe et al. (2011)* who reported non-significant decrease in VA for both distant and near.

Also, this study agreed with the study done by *Mehdizadehkashi et al. (2014)* in their study in Iran also reported significant changes in visual acuity for both distance and near. Their results are in the same line with the study by *Pizzarello (2010)* when visual examination of pregnant women showed myopic shifts during pregnancy with return after delivery to the amount close to pre-pregnancy.

In the present study, the IOP was changed from (15.750 ± 2.403) pre-partum to (18.250 ± 2.074) post-partum with statistically significant difference (P

value <0.001), this indicate decrease in IOP during pregnancy.

In another study done by *Pilas et al. (2010),* they reported a significant decrease in IOP during successive stages of pregnancy. Similarly, *Ataş et al. (2014)* also reported similar findings in second and third trimesters.

Also, this study agreed with the study done by *Goldich et al. (2014)* who demonstrated a decrease in IOP in the group of pregnant women in comparison to the control group ($p < 0.001$). Similar results were obtained by *Sen et al. (2014)*

A study done by *Kump et al. (2010)* in healthy women have shown a statistically significant decrease in IOP during all trimesters of pregnancy compared with non-pregnant women.

CONCLUSION

Pregnancy and lactation represented relative contraindications for laser corneal refractive surgery as transitory tomographic and biomechanical changes may prevent refractive stability.

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تقييم التغيرات التي تحدث في تضاريس القرنية أثناء الحمل

أحمد أبوالسعود، محمد خضر، حاتم محمود

قسم طب وجراحة العيون، كلية الطب، جامعة الأزهر

E-mail: ahmedaboelsoud906@gmail.com

خلفية البحث: أثناء الحمل، تحدث تغيرات فسيولوجية مختلفة تؤثر على معظم أعضاء جسم الأنثى. ومن هذه التغيرات الفسيولوجية تحدث في العين في الحالة الانكسارية نتيجة ترطيب القرنية وكذلك التغيرات الطبوغرافية القرنية. ويمثل التصوير المقطعي للقرنية ثورة حقيقية في تشخيص أمراض القرنية وعلاجها، فهو أساسي في تقييم الأفراد المرشحين لجراحة تصحيح القرنية بالليزر حيث أنه صمم ليكون حساسًا للكشف عن التغيرات الطفيفة في القرنية.

الهدف من البحث: تقييم التغيرات المقطعية للقرنية أثناء الحمل وبعد الولادة المقاسة بنظام سيريوس.

المريضات وطرق البحث: هذه دراسة إستطلاعية شملت 20 عينًا لـ 10 نساء حوامل. خضعن للفحص الشامل للعيون، شاملاً تقييم حدة البصر، والفحص المجهري الحيوي للمصباح الشقي، وقياس ضغط العين، وفحص قاع العين، والتصوير المقطعي للقرنية في مستشفى العيون كفر الشيخ خلال الفترة من أكتوبر 2020 إلى مارس 2021.

نتائج البحث: حدثت تغيرات ذات دلالة إحصائية في حدة البصر غير المصححة و حدة البصر المصححة عن بعد و ضغط العين و قياس القرنية الحاد ومتوسط قياس القرنية و عمق الغرفة الأمامية ،في حين لم تسجل أية نتائج ذات دلالة إحصائية فيما يتعلق قياس القرنية المسطح و

سماكة القرنية المركزية و أنحف سمك القرنية و الارتفاع الأمامي و الارتفاع الخلفي و زاوية الغرفة الأمامية اثناء الحمل وبعد الولادة.

الاستنتاج: يجري أي تدخل جراحي أو عملية تصحيح أبصار أثناء الحمل وبعد الولادة علي الأقل بثلاثة أشهر لأنه يحدث تغيرات في الحالة الانكسارية للعين، وهذه التغيرات الفسيولوجية و الهرمونية تؤثر علي القرنية.

الكلمات الدالة: التصوير المقطعي للقرنية، الحمل، نظام سيريوس.