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Comparative Study between Pupillary Diameters and Higher Order Aberrations between Pregnant and Non-Pregnant Females

Nermeen Mahmoud Badawi* and Ahmed A Al-Hagaa

Ophthalmology Department, Faculty of Medicine, Menofia University, Egypt

***Corresponding Author:** Nermeen Mahmoud Badawi, Ophthalmology Department, Faculty of Medicine, Menofia University, Cairo, Egypt.

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Abstract

Purpose: To detect the effect of pregnancy on pupillary diameter and higher order aberrations and its impact on refractive surgery decision.

Materials and Methods: This study is a case-control study which was performed on 800 eyes of 400 female patient, including 400 eyes of 200 pregnant females between 25 and 29 years with gestational ages between 32 and 36 weeks, while the other 200 females (400 eyes) were non-pregnant. Photopic and scotopic pupillary diameter and higher order aberrations were measured for all eyes. results were statistically analysed and compared and between pregnant and non-pregnant females.

Results: Photopic and scotopic pupillary diameter were statistically higher in pregnant than in non-pregnant females. Some higher order aberrations (Total third order aberrations, coma aberration, spherical aberration, total fifth order aberrations and total higher order aberrations) were statistically higher in pregnant than in non-pregnant females.

Keywords: Pregnancy; Pupil; Diameter; Refraction; Aberrations; Wavefront

Abbreviations

RMS: Root Mean Square; UCVA: Uncorrected Visual Acuity

Introduction

Pregnancy was proven to causes multiple systemic and ocular changes, most of them are related to the hormonal changes during pregnancy [1]. Most of these changes occur in the third trimester as hormonal activity is maximum in this period [2]. The pupillary size is controlled by the balance between the 2 components of the autonomic nerve supply to the pupil which are the sympathetic and parasympathetic innervation [3,4]. For many years, ocular aberrations were believed to be myopia, hyperopia and astigmatism only as there was no machines which can detect other aberrations. With the invention of aberrometers, it is now possible to detect many aberrations other than myopia, hyperopia and astigmatism which we call higher order aberrations. The order of aberration refers to the complexity of the shape of the wavefront image coming out of the eye so, lower order aberrations refer to myopia, hyperopia and astigmatism which produce simple deformity of the wavefront image (considered as first and second order aberrations) while higher

order aberrations (from third to sixth order) refer to other types of aberrations (like trefoil, tetrafoil and coma aberration) which produce complex deformity of the wavefront image [5]. The root mean square (RMS) is a quantitative measure to the degree of wavefront aberration or in other words it is the method by which we can convert the wavefront image to a mathematical number that can be used in statistical analysis [6]. The pupillary diameter was proved to have influence on higher order aberrations as larger pupil creates more ocular aberrations [7,8].

Aim of the Study

The aim of this study was to show if pregnancy has an effect on pupillary diameter and higher order aberrations or not.

Materials and Methods

A detailed written consent was signed by each patient before participating in the study. This study is a case-control study that was performed on 800 eyes of 400 females, in the period from June 2014 to October 2018. The procedures followed the ethical standards of the Helsinki declaration and were approved by the Ethical Committee of Menofia University. All females included in the study aged between 25 and 29 years. They were divided into 2 groups: group A consists of 400 eyes of 200 pregnant females and group B (control group) which consists of 400 eyes of 200 non pregnant females. Females in group A were pregnant between 32 and 36 weeks of gestational age all having normal pregnancy stated by a report from an obstetrician.

No systemic diseases were reported by any case.

Inclusion criteria: Every eye included in the study has:

- Completely free ophthalmological examination including both anterior and posterior segments.
- UCVA 20/20 using the Snellen's E chart.
- No or minor refractive error (spherical equivalent do not exceed ± 0.5 diopter).

Exclusion criteria:

- Any systemic or ocular disease.
- History of ocular trauma or intraocular surgery.
- Regular use of systemic or ocular drugs for any reason.
- UCVA less than 20/20.
- Significant refractive error with spherical equivalent more than ± 0.5 diopter.

Each eye included in the study had underwent measurements of photopic and scotopic pupillary diameter and higher order aberrations using Allegro Analyzer wavefront system (Wave light Laser Technology AG, Germany). RMS value was calculated for each type of higher order aberrations.

Data were collected, tabulated, and analyzed using the paired t test. Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS: IBM Corporation, Armonk, New York, United States, version 25, 2017). The result was considered as statistically significant when P value was ≤ 0.05.

Results

Age in group A ranged between 25 and 29 years with mean age 27.22 ± 1.11 years, while in group B had a range of age between 25 and 29 years with mean age 27.31 ± 1.14 years. With no statistically significant differences between the 2 groups. In group A, the mean photopic pupil diameter was 3.89 ± 0.63 mm while in group B, it was 3.38 ± 0.34, being significantly higher in group A (P: 0.029). Regarding the scotopic pupil diameter in group A, it was 6.83 ± 0.54 mm while in group B, it was 6.27 ± 0.32 mm. that was also significantly higher in group A (P: 0.014) (Table 1).

	Group A	Group B	(P value)
The mean age	27.22 ± 1.11 years	27.31 ± 1.14 years	1.9
UCVA	20/20 in all eyes	20/20 in all eyes	
The mean photopic pupil diameter	3.89 ± 0.63 mm	3.38 ± 0.34 mm	0.029
The mean scotopic pupil diameter	6.83 ± 0.54 mm	6.27 ± 0.32 mm	0.014

Table 1: Comparison between the results of both groups concerning age, uncorrected visual acuity (UCVA), the mean photopic pupil diameter and the mean scotopic pupil diameter.

As for the higher order aberrations, in group A, total third order aberrations and coma aberration were significantly higher. Concerning trefoil aberration, there was no significant difference between both groups (Table 2).

In group A, spherical aberration was significantly higher. Concerning total fourth order aberrations, quadrafoil aberration and

secondary astigmatism there was no significant difference between both groups (Table 3).

	Group A	Group B	P value
The mean RMS value of total third order aberrations (coma and trefoil)	0.645 ± 0.069	0.513 ± 0.082	0.03
The mean RMS value of coma aberration	0.287 ± 0.036	0.21 ± 0.031	0.029
The mean RMS value of trefoil aberration	0.161 ± 0.020	0.163 ± 0.011	0.102

Table 2: Comparison between the results of both groups concerning third order aberrations.

	Group A	Group B	P value
The mean RMS value of total fourth order aberrations (spherical aberration, quadrafoil and secondary astigmatism)	0.478 ± 0.053	0.458 ± 0.052	0.113
The mean RMS value of spherical aberration	0.167 ± 0.007	0.143 ± 0.005	0.026
The mean RMS value of quadrafoil aberration	0.062 ± 0.008	0.061 ± 0.006	0.096
The mean RMS value of secondary astigmatism	0.073 ± 0.007	0.069 ± 0.006	0.079

Table 3: Comparison between the results of both groups concerning fourth order aberrations.

In group A, total fifth order aberrations were significantly higher. Concerning total sixth order aberrations, there was no significant difference between both groups (Table 4).

	Group A	Group B	P value
The mean RMS value of total fifth order aberrations (pentafoil, secondary trefoil and secondary coma)	0.071 ± 0.007	0.052 ± 0.006	0.027
The mean RMS value of total sixth order aberrations (hexafoil, secondary quadrafoil, tertiary defocus and tertiary astigmatism)	0.044 ± 0.003	0.042 ± 0.003	0.078

Table 4: Comparison between the results of both groups concerning fifth and sixth order aberrations.

In group A, total higher order aberrations were significantly higher. Concerning total aberrations (both lower and higher order), there was no significant difference between both groups (Table 5).

	Group A	Group B	P value
The mean RMS value of total higher order aberrations	0.657 ± 0.019	0.502 ± 0.014	0.041
The mean RMS value of total aberrations (both lower and higher order)	4.892 ± 1.346	4.864 ± 1.311	

Table 5: Comparison between the results of both groups concerning total higher order and total aberrations.

Discussion

Ocular changes occur during pregnancy mainly as a result of hormonal changes. Pregnancy can produce changes in refraction, corneal sensation, visual acuity, and intraocular pressure, however, most likely these changes are not permanent in nature, as after several weeks of labor all hormonal changes return to their original state [9]. Changes in pupillary diameter are controlled by the activity of sympathetic and parasympathetic nervous system. sympathetic activity stimulates the dilator muscle, producing mydriasis, while parasympathetic activity stimulates the constrictor muscle, producing miosis [10]. Baum., *et al*. had evaluated autonomic nervous system activity in obese children, adolescents and pregnant females by analysis of pupillary diameter, heart rate and sympathetic skin response. They found that both parasympathetic and sympathetic activities are reduced in obesity with increased sympathetic activity and consequently pupillary diameter during pregnancy similar to the results we found in our study [11]. Dundaroz., *et al*. assessed autonomic nervous system function with pupillary diameter measurements in children with nocturnal enuresis [12] and they found significant pupillary dilatation with decreased parasympathetic activity in such children. In our study it was found that both photopic and scotopic pupil diameter were measured and the results showed statistically significant increase in photopic and scotopic pupillary diameter during the third trimester of pregnancy. In our study, evaluation of higher order aberrations showed that total third order aberrations, coma aberration, spherical aberration, total fifth order aberrations, and total higher order aberrations were statistically higher in pregnant than in non-pregnant females. Several studies showed the effect of pupillary diameter on higher order aberrations as increased pupil size is associated with greater levels of higher order aberrations particularly in low lighting conditions [13,14]. These findings correlate with the activity of sympathetic nervous system during pregnancy. Kuo., *et al*. found that autonomic nervous activity has biphasic response dur-

ing pregnancy as evidenced by heart rate monitoring. The results showed that autonomic nervous system activity shifted from lower sympathetic and higher parasympathetic tone in the first trimester towards higher sympathetic and lower parasympathetic tone in the third trimester. They concluded that hemodynamic changes during pregnancy and aortocaval compression caused by the large uterus might be responsible for these changes [15]. Greenwood., *et al*. found that sympathetic activity was increased in females during normal uncomplicated pregnancy and was increased in a greater degree in females with hypertension during the third trimester of pregnancy [16]. Page., *et al*. in an animal study, reported that GABAergic neurons in the paraventricular nucleus (PVN) of the hypothalamus which normally suppress the activity of sympathetic nervous system showed less inhibition during pregnancy with increased sympathetic activity in pregnant rats when compared to female non-pregnant rats [17]. All previous results correlate with our results.

Conclusion

Normal pregnancy is associated with statistically significant higher photopic and scotopic pupillary diameter with significantly higher some of ocular higher order aberrations (Total third order aberrations, coma aberration, spherical aberration, total fifth order aberrations, and total higher order aberrations). So, it is better not to perform a refractive surgery during pregnancy as it significantly influences photopic and scotopic pupillary diameter and higher order aberrations which can affect both the technique chosen for refractive surgery and the results as well.

Conflict of Interest

There is no financial or any conflict of interest exists.

Bibliography

1. F Mackensen., *et al*. "Ocular changes during pregnancy". *Deutsches Arzteblatt International* 111.33-34 (2014): 567-576.
2. JA Ebeigbe., *et al*. "Ocular changes in pregnantNigerian women". *Nigerian Journal of Clinical Practice* 15.3 (2012): 298-301.
3. PH Heller., *et al*. "Autonomic components of the human pupillary light reflex". *Investigative Ophthalmology and Visual Science* 31.1 (1990): 156-162.
4. F Fotiou., *et al*. "Automated standardized pupillometry with optical method for purposes of clinical practice and research". *Clinical Physiology* 20.5 (2000): 336-347.
5. Krueger R., *et al*. "Wavefront customized visual correction: The quest for super vision". 2nd edition. Thorofare, NJ: Slack, Inc (2004).
6. Applegate RA., *et al*. "Are all aberrations equal?" *Journal of Refractive Surgery* 18 (2002): S556-562.
7. Applegate RA., *et al*. "Interaction between aberrations can improve or reduce visual performance". *Journal of Cataract and Refractive Surgery* 29 (2003): 1487-1495.
8. J Liang and DR Williams. "Aberrations and retinal image quality of the normal human eye". *Journal of the Optical Society of America A: Optics and Image Science, and Vision* 14.11 (1997): 2873-2883.
9. IA Qureshi. "Measurements of intraocular pressure throughout the pregnancy in Pakistani women". *Chinese Academy of Medical Sciences* 12.1 (1997): 53-56.
10. MM Bradley., *et al*. "The pupil as a measure of emotional arousal and autonomic activation". *Psychophysiology* 45.4 (2008): 602-607.
11. P Baum., *et al*. "Dysfunction of autonomic nervous system in childhood obesity: a cross-sectional study". *PLoS ONE* 8.1 (2013): Article ID e54546.
12. R Dundaroz., *et al*. "Pupillometric assessment of autonomic nervous system in children with functional enuresis". *International Urology and Nephrology* 41.2 (2009): 231-235.
13. T Oshika., *et al*. "Influence of pupil diameter on the relation between ocular higher order aberration and contrast sensitivity after laser in situ keratomileusis". *Investigative Ophthalmology and Visual Science* 47.4 (2006): 1334-1338.
14. B Winn., *et al*. "Factors affecting light-adapted pupil size in normal human subjects". *Investigative Ophthalmology and Visual Science* 35.3 (1994): 1132-1137.
15. CD Kuo., *et al*. "Biphasic changes in autonomic nervous activity during pregnancy". *British Journal of Anaesthesia* 84.3 (2000): 323-329.
16. JP Greenwood., *et al*. "Sympathetic neural mechanisms in normal and hypertensive pregnancy in humans". *Circulation* 104.18 (2001): 2200-2204.

17. MC Page., *et al*. "GABA in the paraventricular nucleus tonically suppresses baroreflex function: alterations during pregnancy". *The American Journal of Physiology-Regulatory, Integrative and Comparative Physiology* 300.6 (2011): R1452-R1458.