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Assessment of Choroidal Thickness in Keratoconus Patients Using Optical Coherence Tomography Among Adult Saudi Patients

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Abstract

***Purpose:** To investigate macular choroidal thickness in keratoconus patients and correlate it with keratoconus severity.*

***Materials and Methods:** Cross sectional case control study, where a total of 24 subjects aged from 18 to 40 years old, were recruited from ophthalmology clinic of a tertiary care hospital. They were divided into two groups: Control group and keratoconus group (who's already diagnosed by cornea specialist according to slit lamp biomicroscopic findings and corneal topography). All subjects underwent full ophthalmological examination including: Visual acuity (VA) using Snellen chart, intraocular pressure IOP measurement using Goldman applanation tonometer, corneal curvature and thickness measurement using Pentacam, and choroidal thickness(ChT) using optical coherence tomography (OCT).*

***Results:** Our study carried out on 11 normal and 13 Keratoconus patients revealed that there are no statically significant difference in choroidal thickness and macular thickness between control and keratoconus groups, except at temporal 0.75mm, and the choroidal thickness was significantly higher in the keratoconus group.*

***Conclusion:** In conclusion, studying the correlation between keratoconus and choroidal thickness can be used as a predictive marker of altered basement membrane - retinal pigment epithelium interactions affecting the integrity of outer blood retinal barrier causing CSC and CNM which are common KC association. To the best of our knowledge, our research is the first study correlating keratoconus and posterior segments parameters among adult Saudi population.*

Keywords: *Choroidal thickness, Keratoconus, Macula, Optical coherence tomography.*

Introduction

Keratoconus (KC) is a progressive, bilateral asymmetrical, non-inflammatory disorder, in which the central portion of the cornea becomes thinner and bulges forward in a conical shape [1]. Although it is an idiopathic disease, it can be affected by positive family history and associated with atopy, Down's syndrome, central serous chorioretinopathy (CSC) and choroidal neovascularization (CNM) [2].

The choroid is a highly vascularized structure, lying between the retina and sclera, extending from the ora serrate to the optic nerve then joins the ciliary body [3]. The subfoveal choroidal thickness (ChT) ranges from 272 µm to 311 µm [4]. ChT is altered with many ocular and systemic diseases [5].

Methods

A total of 24 subjects aged 18 to 40 years old with best-corrected Snellen VA greater than 20/40 were eligible

for this study. They were divided into two groups: Control group (11 subjects) and keratoconus group (13 subjects). Subjects with ocular hypertension, glaucoma, media opacity, prior ocular surgery, laser treatment, retinal diseases or neurological disorders were excluded from the study.

All subjects underwent full ophthalmological examination including: **1)** VA by Snellen chart, 2) SE using Auto refraction (NIDEK, Japan), 3) IOP measurement by Goldman applanation tonometer (Haag-Streit, UK), 4) Corneal curvature and thickness using Pentacam (Oculus, U.S), 5) Choroid and macular thickness using optical coherence tomography (OCT provides high-resolution, cross-sectional image of retina where we measured the choroidal thickness manually from this scan. We determine 5 various locations (Sub foveal, Nasal 1.50, 0.75mm and Temporal 1.5, 0.75 mm) by using caliper measuring choroidal thickness from the outer limit of the hyper-reflective band representing the retinal pigment epithelium to the outer boundary of the choroid.

Ethical consideration

The study was approved by the concerned Ethical Committee. Its protocol was explained to each participant at the time of recruitment and informed consent was obtained according to the Declaration of Helsinki.

Statistical Analysis

Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) version 22. 0 software (SPSS Inc., Chicago, IL, USA). Normality was checked using the Kolmogorov- Semirnov test. All variables were expressed as Mean ± Standard deviation. We used student t-test for two independent samples to compare between control and KC groups. Also, we calculated Pearson correlation coefficient (r) to examine possible relationships between measured variables. A P value < 0.05 is considered statistically significant.

Results

Demographic Characteristics

Twenty-one eyes of eleven patients were enrolled in control group and one eye was missed, while in keratoconus group nineteen eyes of fourteen patients were included and nine eyes were excluded from analysis (4 keratoplasty, 4 ectasias, 1 intra corneal ring). All examined patients in both groups were males, with mean age 26.857 ± 5.369 (19-36) and 29.789 ± 5.40 (21-39) years for control and keratoconus group respectively. There was no statically significant difference in the age between both groups (P = 0.094) (Table1).

Table 1. *Demographic data*

	Control group	KC group	P-value
Number of eyes	21	19	-
Age	26.857 ± 5.369	29.789 ± 5.40	0.094
Sex	Males		-

Table 2 and 3 demonstrate descriptive analyses of anterior and posterior ocular parameters in control and keratoconus groups.

Table 2. *Descriptive analyses of anterior ocular parameters (SE, IOP, CC, and CCT) for both groups.*

	Control group				KC group			
	N	Mini	Max	Mean ± SD	N	Mini	Max	Mean ± SD
SE	21	-14.0	3.25	-2.01 ± 4.47	16	-14.75	2.25	-5.63 ± 4.74
IOP	21	10	21	14.2 ± 3.53	19	10	20	14.0 ± 3.08
CC	21	39.6	45.2	42.3 ± 1.33	19	39.5	57.2	46.8 ± 4.65
CCT	21	501	592	552 ± 25.34	19	341	554	477 ± 54.26

Table 3. *Descriptive analyses of posterior ocular parameters (ChT and macular thickness) for both groups*

	Control Group				KC Group			
	N	Mini	Max	Mean ± SD	N	Mini	Max	Mean ± SD
ChT (Nasal 1.5mm)	21	155	280	202 ± 37.37	19	150	316	229 ± 45.84
ChT (Nasal 0.75mm)	21	157	304	210 ± 40.67	19	150	336	236 ± 53.32
ChT (Sub foveal)	21	163	306	220 ±40.67	19	166	357	252 ± 57.20
ChT (Temporal 0.75 mm)	21	145	287	200 ± 37.71	19	153	352	238 ± 57.70
ChT (Temporal 1.5 mm)	21	150	293	209 ± 40.62	19	155	331	232 ± 48.94
Macular thickness	21	157	347	267 ± 37.95	19	231	320	232 ± 48.94

There was no statically significant difference in Choroidal thickness and macular thickness between both groups except at (Temporal location 0.75mm) where the choroidal thickness is significantly higher in the keratoconus group (238.26 ± 48.946) than in the control group (200.86 ± 37.711 µm) and P =0. 019 (Table 4).

Table 4. *Mean macular and choroidal thickness measurements at various locations in both groups.*

	Control (n = 21)	KC (n = 19)	P-value
	Mean ± SD	Mean ± SD	
ChT (Nasal 1.5mm)	202 ± 37.37	229 ± 45.84	0.055
ChT (Nasal 0.75mm)	210 ± 41.69	236 ± 53.32	0.094
ChT (Sub foveal)	220 ± 40.67	252 ± 57.20	0.053
ChT (Temporal 0.75mm)	200 ± 37.71	238 ± 57.70	0.019*
ChT (Temporal 1.5mm)	209 ± 40.62	232 ± 48.94	0.126
Macular thickness	267 ± 37.95	277 ± 25.31	0.358

*significant

In control group, we found a significant positive correlation between spherical equivalent and choroidal thickness at various locations in control than keratoconus patients. However, there is positive correlation between intraocular pressure and choroidal thickness except at Nasal 1.5mm where P-value is < 0.05. While central corneal thickness and corneal curvature showed no correlation with choroidal thickness and macular thickness (Table 5).

Table 5. *Correlations between anterior and posterior ocular parameters (control group)*

	SE		IOP		CC		CCT	
	Pearson correlation	P-value	Pearson correlation	P-value	Pearson correlation	P-value	Pearson correlation	P-value
ChT (Nasal 1.5mm)	-.795**	.000	.419	.059	.157	.498	-.119	.608
ChT (Nasal 0.75mm)	-.831**	.000	.469*	.032	.114	.662	-.117	.613
ChT (Sub foveal)	-.806**	.000	.583**	.006	.102	.660	-.031	.895
ChT (Temporal 0.75mm)	-.813**	.000	.449*	.041	.125	.589	-.095	.681
ChT (Temporal 1.5mm)	-.812**	.000	.560**	.008	.114	.623	.003	.990
Macular thickness	.116	.616	-.111	.633	.205	.372	.151	.513

*significant ** highly significant

In keratoconus group, a moderate positive correlation was proved between spherical equivalent, corneal curvature and choroidal thickness at various locations. However choroidal and macular thickness didn't show any statistical significance with intraocular pressure and central corneal thickness (Table 6).

Table 6. *Correlations between anterior and posterior ocular parameters for KC group*

	SE		IOP		CC		CCT	
	Pearson correlation	P-value	Pearson correlation	P-value	Pearson correlation	P-value	Pearson correlation	P-value
ChT (Nasal 1.5mm)	-.675**	.004	-.263	.277	.703**	·001	-.237	.586
ChT (Nasal 0.75mm)	-.742**	.001	-.301	.210	.641**	·003	-.244	.314
ChT (Sub foveal)	-.738**	.001	-.287	.234	.636**	·003	-.284	.239
ChT (Temporal 0.75mm)	-.704**	.001	-.234	.334	.644**	·003	-.263	.277
ChT (Temporal 1.5mm)	-.536*	.032	-.183	.452	.754**	·000	-.254	.295
Macular thickness	.174	.520	.154	.528	.106	.667	-.133	.586

Discussion

Our study carried out on 11 normal and 13 Keratoconus patients revealed that there are no statically significant difference in choroidal thickness and macular thickness between control and keratoconus groups, except at temporal 0.75mm, and the choroidal thickness was significantly higher in the keratoconus group.

Keratoconus is a progressive, bilateral asymmetrical, non-inflammatory disorder associated with various risk factors. Histopathological changes observed in keratoconus, include: decreased density of basal layer cells of the corneal epithelium with subsequent degeneration of proteolytic enzymes causing instability of Bowman's layer and loss of stromal collagen fibrils. In advanced cases, Descemet's membrane is significantly disrupted [1].

The choroid is a highly vascularized structure, lying between the retina and sclera, extends from the ora serrate to the optic nerve then joins the ciliary body. The choroid consists of blood vessels, melanocytes, fibroblasts, resident immuno competent cells, supporting collagenous and elastic connective tissue [6].

In our study we observed that choroidal thickness is thinner nasally, and temporally and is thicker in the subfoveal region, these findings fit well with Serkan (2018) study [2]. Moreover Margolis and Spaide (2009) study [7] proved that choroidal thickness decreases rapidly in the nasal direction which is an agreement with our results.

The mean of choroidal thicknesses at different locations and macular thickness were insignificant between the control and keratoconus groups (202 ± 37.37 vs. 229 ± 45.84, P =0.055) for nasal 1.5mmm (210 ± 41.69 vs. 236 ± 53.32, p =0.094) for nasal 0.75mm, (220 ±40.67 vs. 252 ± 57.20, P=0.053) for sub foveal, (209 ± 40.62 vs. 232 ± 48.94, P =0.126) for temporal 1.5mm and (267 ± 37.95 vs. 277 ± 25.3, P=0.358) for macular thickness. But choroidal thickness was statically significant between both groups at temporal 0.75mm (200 ± 37.71 vs. 238 ± 57.70, P= 0.019).

Our findings are confident with Ihsan Yilmaz et al (2018) [8] that reported insignificant change in Cht and CMT between normal and keratoconus patients in pediatric age group demonstrating that keratoconus may not affect CMT and CT or vice versa.

Previous studies Rosa Gutierrez-Bonet (2018) et al [9] and Serkan [2] showed significant difference of ChT between healthy and KC eyes. They reported that KC patients had a thicker choroid, which is inconsistent with our data.

Serkan revealed that CCT was significantly correlated with choroidal thickness except at Nasal 0.75mm which is not confident with us (no correlation between ChT and CCT in both groups).

Moreover we proved a correlation between SE and ChT in both groups which is in agreement with Tan and Cheong (2014) [10] and inconsistent with Serkan [2].

Conclusion

In conclusion, studying correlation between keratoconus and choroidal thickness can be used as a predictive marker of altered basement membrane - retinal pigment epithelium interactions affecting the integrity of outer blood retinal barrier causing CSC and CNM which are common KC association. To the best of our knowledge, our research is the first study correlating keratoconus and posterior segments parameters among adult Saudi population.

Recommendations: We think it is appropriate to re-evaluate the results in this study with large sample size. Also it is advisable to assess choroidal and macular thickness in keratoconus patients routinely.

Author Disclosure Statement

The authors declare no potential conflicts of interest with respect to the authorship, and/or publication of this article.

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