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Central corneal thickness of healthy Saudi children

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Purpose
The aim of this study was to determine the central corneal thickness (CCT) of healthy Saudi children aged 7–12 years and investigate variations in CCT according to age and sex.

Patients and methods
In this prospective study, one eye was analyzed from each of 412 healthy children. The CCT was measured using a noncontact Nidek CEM 530 specular microscope. A regression analysis was carried out to determine the relationship between CCT and age, and an unpaired *t*-test was used to compare findings between the sexes; CCT percentiles were then calculated for each age.

Results
The median CCT among all participants was 576 μm. Regression analysis detected a strong positive correlation between CCT and age ($r = 0.64$, $P < 0.0001$), and CCT was found to increase by 8.26 μm each year. The mean CCT of boys was 0.45 μm thicker than that of girls, but this difference was not statistically significant ($P = 0.83$).

Conclusion
The CCT increased with age from 7 to 12 years, and there was no statistically significant difference in the CCT of boys and girls.

Keywords:
central corneal thickness, Nidek CEM 530 specular microscope, noncontact

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Introduction

It is essential that the central corneal thickness (CCT) of healthy children without glaucoma is determined for each age and race. The CCT is important in the diagnosis and treatment of pathological myopia, keratoconus, ocular hypertension, and open-angle glaucoma [1–3]. Numerous studies of CCT measurements among adults have detected a significant racial difference among different ethnic groups [4,5].

The development of new noncontact specular microscopes such as the Nidek CEM 530 specular microscope has facilitated the measurement of parameters such as the mean CCT. This microscope enables the determination of the CCT without the risk of corneal epithelial abrasion and infection transmission, which is associated with ultrasound pachymetry, and it is also easy to use in children [6]. Furthermore, a handheld pachymeter can potentially incur errors such as inaccurate placement of the probe obliquely to the corneal surface [7].

A number of studies have measured the CCT of White and African-American [8], Hispanic [8], and Asian [5] children. Hussein *et al.* [9] reported that the CCT and paracentral corneal thickness were found to increase over time, and reached adult thickness between 5 and 9 years of age. However, Dai and Gunderson [8] found no difference among age groups within the 0–18-year range when these were stratified into groups of less than 2 years, 2–4 years, 5–9 years, and 10–18 years. Rushood *et al.* [10] reported a CCT of 616 ± 61 μm in full-term Saudi infants. These different findings in different studies are indicative of differences on the basis of ethnicity. To the best of our knowledge, no study has examined the CCT of Saudi children aged 7–12 years.

The aim of this study was therefore to determine the CCT of healthy Saudi children aged 7–12 years and to investigate the effects of age and sex on CCT.

Patients and methods

A total of 412 children aged 7–12 years were selected randomly from a school population in Riyadh, Saudi Arabia. Comprehensive anterior segment examinations of all participants were performed using a slit-lamp biomicroscope. Exclusion criteria included dry eye and ocular trauma, a history of ocular surgery or intraocular abnormalities, a family history of a hereditary corneal disorder, increased intraocular pressure, uveitis, corneal opacity, evidence of endothelial dystrophy on slit-lamp biomicroscopy, and any systemic disease, such as diabetes mellitus. Spherical and cylindrical refractions and intraocular pressure were determined by autorefractometry (Auto Kerato-Refracto-Tonometer TRK-1P-Topcon Inc., Tokyo, Japan). One eye was selected randomly from each participant using a table generated in Microsoft

Excel 2007 (Microsoft Corporation, Redmond, WA, USA). All data were collected in the afternoon and between 10:00 a.m. and 12:00 p.m. A single investigator performed all CCT measurements using a noncontact Nidek CEM 530 specular microscope (Nidek Co., Tokyo, Japan). The aim of the study was explained to the parents of all participating children, and informed consent was obtained from each parent before the examination. The study was carried out in conformance with the ethical considerations laid out in the 2008 Declaration of Helsinki, and the study protocol was approved by the research ethics review board of the College of Applied Medicine Science at the King Saud University.

Noncontact specular microscopy method

A noncontact Nidek CEM 530 specular microscope (Nidek Co.) was used to obtain all CCT measurements. The participants' head was positioned against the head band and chin rest, and they were then instructed to look straight ahead at the fixation targets. Images of the central cornea area were captured after proper positioning of the alignment dot, circle, and bar on the screen. CCT analyses were carried out using automated measurements with the retracing method using the manufacturer's built-in image analysis software. The mean CCT was calculated automatically. The images were printed with the analyzed data.

Results

The study included 412 healthy children (204 girls), and one eye was selected from each child. The mean age of the children was 9.50 ± 2.00 years (range 7–12 years). The spherical equivalent was −1.25 ± 0.75 D (range −0.50 to −3.00 D) and the median CCT was 576 μm. The reference percentiles for CCT as a function of age are summarized in Table 1. The coefficient of determination (R^2) was 0.41 ($y = 498.4323 + 8.2588x$). The median CCT increased with age (Table 2). Boys had a 0.45 μm thicker mean CCT than girls, but the difference was not statistically significant ($P = 0.83$).

Table 1 Central corneal thickness reference percentiles as a function of age among children aged 7–12 years

Age (years)	Percentiles (μm)						
	5th	10th	25th	50th	75th	90th	95th
7	506.00	538.50	552.00	556.50	567.50	579.00	586.00
8	553.50	559.00	562.75	567.00	572.25	575.50	577.25
9	550.70	554.00	558.50	571.00	579.00	588.40	608.30
10	554.80	560.80	574.00	581.00	586.00	589.20	606.80
11	574.95	578.70	581.00	585.50	590.00	612.30	617.15
12	582.00	584.00	586.00	597.00	613.00	628.00	630.00

Table 2 Median central corneal thickness values according to age

Age (years)	7	8	9	10	11	12
CCT (μm)	556.50	567.00	572.00	581.00	585.50	597.00

CCT, central corneal thickness.

Discussion

Numerous studies have reported a decrease in CCT once adulthood is reached [8,9] as well as racial differences in CCT [1,11]. In contrast, a pattern of CCT increase with age has been reported in children [11,12]. Hussein *et al.* [9] reported a mean increase in CCT with age reaching adult thickness by the age 5 years. As their study only included 18 children older than 10 years of age, there were insufficient numbers of children to conclude whether the trend continued after 9 years. Another study reported no association between CCT and age in children [13]. This might be because of the exclusion criteria as children aged 8 years were excluded and the study sample was too small to detect an effect of age on CCT [8,13]. In Saudi Arabia, this age range represents the base of our population pyramid, and could thus be a benchmark for CCT measurements to improve our understanding of the effects of age and sex on pathogenic conditions of the cornea, such as pathological myopia and keratoconus.

Our finding that the median CCT increased with age (by 8.6 μm annually) supports reports from previous studies [11,12]. Bradfield *et al.* [11] reported a weak positive correlation between CCT and age ($r = 0.06$) in White and Hispanic children, with CCT increasing by 1.50 μm annually. Yet, in the case of African-American children, although a weak positive correlation between CCT and age was also detected ($r = 0.10$), the CCT only increased by 0.80 μm annually. The differences in the annual increase in CCT might be because of racial variations [11,12].

Ethnicity-based differences in CCT have been documented in several studies [1,11]. White and Hispanic children reportedly have a similar CCT, whereas African-American children have a lower CCT across all age groups. In addition, the mean CCT among East Asian children is intermediate between that of White and Hispanic and African-American children. The clinical significance of these racial differences is unknown. Our study indicates that Saudi children have slightly different CCT values compared with White and Hispanic children (Table 3).

Bradfield *et al.* [11] reported that boys had a 5 μm thicker CCT than girls and that this difference was statistically significant ($P = 0.003$). However, in our study, no significant difference was found as the mean difference of 0.45 μm was not statistically significant ($P = 0.83$). The results of this study are supported by

Table 3 Reference percentiles for White and Hispanic participants aged 7–12 years

Age (years)	Percentiles[a]						
	5th	10th	25th	50th	75th	90th	95th
7	506	520	542	567	592	614	627
9	509	523	545	570	595	617	630
12	512	525	548	573	597	620	633

The reference percentiles were derived from a regression model of CCT as a function of age [11]; CCT, central corneal thickness; [a]Each cell contains a CCT value in micrometers.

a previous study reporting that there is no significant difference between boys and girls [14].

Conclusion

The CCT increases with age between 7 and 12 years, and there is no statistically significant difference in CCT between boys and girls.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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