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Assessment of anterior segment parameters in children with obesity

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Abstract

Purpose: To evaluate whether Pentacam-Scheimpflug imaging of anterior segment parameters are different in obese children than in normal children.

Methods: This prospective comparative study was conducted using a total of 40 obese children and 41 healthy children. All subjects underwent comprehensive ophthalmologic examinations, including refraction, intraocular pressure, anterior segment and fundus examination. In addition, central corneal thickness (CCT), anterior chamber depth (ACD), anterior chamber volume (ACV), and anterior chamber angle (ACA) values were measured using a Pentacam-Scheimpflug camera.

Results: The mean CCT, ACD, ACV, and ACA values were similar in obese and healthy pediatric individuals. The correlation analysis revealed no statistically significant influence of BMI, age, and sex for any measurements of anterior segment parameters in the obese and control groups.

Conclusion: These results may be helpful to the clinician in assesment of diagnosis and follow-up of obese children with additional ocular pathologies.

Introduction

Obesity is a major public health problem increasing at staggering rates in many countries. Childhood obesity has more than doubled in children and quadrupled in adolescents over the past 30 years. In 2012, more than one third of children and adolescents were overweight or obese. The impact of obesity on health is widespread and the deleterious effects of obesity on the cardiovascular and metabolic systems are well documented. However, the potential ocular effects of obesity are less well known. Different studies have identified an association between obesity and ocular hypertension, cataract, age-related macular disease, diabetic retinopathy, and diseases of oculomotor nerves [1-7].

Although obesity is a serious public health issue in children and adolescents, all previous investigations were carried out with adult subjects.

A review of anterior segment parameters like central corneal thickness (CCT), corneal volume (CV) anterior chamber depth (ACD), anterior chamber volume (ACV), anterior chamber angle (ACA) play a role in certain anterior segment anomalies and influence surgical decisions [8]. These anterior segment parameters were measured with a Pentacam, a noninvasive and three-dimensional corneal topographer, providing an evaluation of the anterior segment.

This study aimed to assess the anterior segment parameters with the Pentacam rotating Scheimpflug camera in obese children and then compare these results with a group of normal children.

Materials and methods

Study population and design

This prospective and comparative study, consisting of obese and healthy pediatric individuals younger than 18 years old, was performed at the Clinics of Pediatric Endocrinology, Dr. Sami Ulus Training and Research Hospital of Women's and Children's Health and Diseases, and Department of Ophthalmology, Ankara Numune Training and Research Hospital in Ankara, Turkey. The study was approved by the local ethics committee and conducted in accordance with the ethical principles described by the Declaration of Helsinki. Informed consent to participate in the research study was obtained from a parent or legal guardian.

Body Mass Index (BMI) is defined as a person's weight in kilograms divided by the square of the height in meters, relative to gender and age, and is used to screen for obesity, overweight, healthy weight, or underweight. In a group of children ages 2 to 19, those with a BMI higher than 95 percent, assessed by age- and sex-specific percentiles, are described as obese by the U.S. Centers for Disease Control and

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Prevention [9]. According to the WHO Reference 2007 (ages 5 to 19), obesity is defined as having a BMI greater than two standard deviations above the WHO growth standard median [10]. We used all of these nomograms at every stage of the study, and the standard deviation score measurements were especially useful. The study group included 40 randomly selected obese children referred to us through the Department of Pediatric Endocrinology. The control group consisted of 41 randomly selected non-obese, healthy children. Only the readings of the right eyes were used for analysis. None of the control subjects had any medical history. Exclusion criteria for both groups included: any systemic diseases (hypertension, diabetes mellitus, thyroid disorders, etc.); orbital and ocular diseases (previously known glaucoma and uveitis, ocular trauma, history of intraocular surgery); best corrected visual acuity (BCVA) worse than 20/20; high spherical >±3 dioptri or cylindrical >1.5 diopter refractive error; and a history of wearing contact lenses. All participants underwent a detailed ophthalmologic examination including refractive error; BCVA; slit lamp and dilated fundus examination; and intraocular pressure measured by applanation tonometry and Pentacam Scheimpflug camera imaging.

Pentacam-Scheimpflug camera measurements

The anterior segment parameters were evaluated using the Pentacan rotating Scheimpflug camera (Oculus Inc. Germany) by the same person, and these evaluations were repeated until an acceptable quality image was obtained. This device can perform a complete measurement of the anterior eye segment in less than two seconds, combining a rotating Scheimpflug camera with a static camera to acquire multiple photographs of the anterior segment of the eye. Measurements were made in darkness to standardize all measurements for each subject. CCT, ACD, ACV, ACA measurements were extracted from the obtained topographic and pachymetric maps for statistical analysis.

Statistical analysis

Statistical analysis was performed using IBM SPSS for Windows Version 21.0 Package Programme. Quantitative variables were reported as mean ± standard deviation (SD) or median [min - max], while the qualitative variables were summarized as number and percent. The normality and homogeneity of variance of the data was confirmed. For the comparison of the quantitative measurement values of the two groups, the Student's t test was applied to the values complying with the normal distribution, and the Mann-Whitney U test was applied to those not complying with the normal distribution. The chi-square or Fisher's exact test was used for the comparison of the qualitative data. Spearmen or Pearson correlation tests were used for the correlation analysis. Statistical significance was defined as a p value of 0.05.

Results

Table 1 shows the characteristics of the obese and control groups and the anterior segment parameters. The obese group included 25 female subjects and 15 male subjects. The mean age was 13.1±2.2 years, in a range from 9 to 16 years old. The control group included 23 female subjects and 18 male subjects, and the mean age was 13.4±2.8 years, in a range of 8 to 18 years old. There was no statistically significant difference between the two groups in terms of age and sex. The BMI was significantly higher in the study group (p=<0.001). The mean intraocular pressure (IOP) values were 15.2 [10 - 22] mmHg in the control group and 16.1 [10 - 23] mmHg in the obese group (p=0.103). The CCT, ACD, ACV, and ACA values were 566.7 ± 36.1 µm, 3.0 ± 0.3 mm, 183.6 ± 40.9 mm3, 39.7 ± 6.4º, respectively, in the control group.

Table 1. Statistical comparison of demographic and ocular characteristics of study participants

	Control group (n=41)	Obese group (n=40)	P
Age (years)	13,4±2,8	13,1±2,2	0,636
Sex (female/male) n(%)	23/18 (%56/%44)	25/15 (%62/%38)	0,719
Height (cm)	155,7±12,3	159,6±13,9	0,188
Weight (kg)	49,9±14,9	79,6±18,0	<0,001
BMI (kg/m^2)	20,2±3,6	30,7±3,1	<0,001
IOP (mm Hg)	15.2 [10 - 22]	16.1 [10 - 23]	0,216
CCT (µm)	566,7±36,1	553±41,0	0,134
ACD(mm)	3,0±0,3	3,1±0,3	0,352
ACV (mm^3)	183,6±40,9	184,4±35,4	0,926
ACA(º)	39,7±6,4	40,1±5,5	0,781

BMI: body mass index, IOP: intraocular pressure, CCT: central corneal thickness, ACD: anterior chamber depth, ACV: anterior chamber volume, ACA: anterior chamber angle, Values are described as mean ± SD or median [min - max]

Table 2. Correlation between age and anterior segment parameters

	Control group		Obese group	
	r	p	r	p
CCT	-0,033	0,836	-0,056	0,732
ACD	-0,221	0,166	-0,074	0,655
ACV	-0,181	0,257	-0,144	0,382
ACA	0,011	0,946	0,277	0,088

CCT: central corneal thickness, ACD: anterior chamber depth, ACV: anterior chamber volume, ACA: anterior chamber angle

Table 3. Correlation between sex and anterior segment parameters

	Control group			Obese group		
	Female (n=23)	Male (n=18)	p	Female (n=25)	Male (n=15)	p
CCT	563,7±33,2	568,8±40,3	0,657	554,0±39,2	551,3±45,1	0,841
ACD	3,0±0,4	3,1±0,3	0,428	3,0±0,3	3,2±0,3	0,097
ACV	176,1±42,7	193,2±37,3	0,189	174,7±22,1	200,0±46,6	0,064
ACA	39,3±6,1	40,2±6,9	0,680	39,7±4,4	40,6±7,1	0,631

CCT: central corneal thickness, ACD: anterior chamber depth, ACV: anterior chamber volume, ACA: anterior chamber angle

Table 4. Correlation between BMI and anterior segment parameters

	Control group		Obese group	
	r	p	r	p
CCT	0,302	0,061	0,144	0,374
ACD	-0,112	0,487	-0,303	0,061
ACV	0,018	0,913	-0,171	0,299
ACA	-0,042	0,793	0,160	0,330

CCT: central corneal thickness, ACD: anterior chamber depth, ACV: anterior chamber volume, ACA: anterior chamber angle

In obese group, the CCT, ACD, ACV, and ACA values were 553.0 ± 41.0 µm, 3.1 ± 0.3 mm, 184.4 ± 35.4 mm3, 40.1 ± 5.5º, respectively. There was no significant difference (p>0.05) in the mean CCT, ACD, ACV, and ACA values.

The correlation between BMI, age, sex, and the anterior segment parameters are shown in Tables 2-4. The correlation analysis revealed no statistically significant influence of BMI, age, and sex for any measurements of the anterior segment parameters in the control or obese groups.

Discussion

The assessment of anterior segment parameters is an important part of ophthalmic examination. Anterior segment parameters were

quantitatively assessed using a non-contact method with the patient in a sitting position [11]. Therefore, this assessment has proven to be a valuable tool for visualizing and monitoring anterior-chamber structures in several diseases. In addition, the quantitative documentation of any alterations in these anterior segment parameters may provide useful information that contributes towards our understanding of ocular dynamics.

A number of factors such as age, race, gender, refractive error, and corneal curvature may affect CCT. However, some studies have found that gender, age, mean refractive error, and mean cylindrical refractive error had no significant effect on CCT [12-15]. ACD, ACA, and ACV were correlated with age, gender, and pupil diameter, in accordance with some previous studies [16-18]. A multiple regression model suggests that age, rather than gender or pupil diameter, is the main factor affecting ACD.

There is less data addressing the relationship between obesity and eye diseases, although there have been some mechanical and vascular pathophysiological mechanisms. According to vascular theory, abnormal ocular blood flow and perfusion instability secondary to alternations in autonomic and endothelial dysfunction may cause poor vascular supply[19]. With regard to the mechanical theory, obesity has been postulated to cause excessive intraorbital adipose tissue, increased blood viscosity, and increased episcleral venous pressure [20-24]. Increased blood viscosity and increased resistance at small vessels can cause transient or permanent ischemia. Obesity is defined as having excess body fat [25]. In addition to increased fat mass, the consequences of obesity develop as a consequence of morphological and functional changes within the adipose tissue. Retrobulbar adipose tissue (RAT) extends from the apex of the orbit to the eyelids and surrounds the eyeball, muscles, nerves, and blood vessels. The mean RAT tissue volume measured by magnetic resonance imaging was significantly higher in obese subjects than in normal weight subjects [26]. RAT could be placed into the mechanism of 'mass effect', since its presence can directly or indirectly influence anterior segment parameters.

Although obesity is a serious and widespread public health issue in children and adolescents, there are no studies examining anterior segment parameters in obese pediatric population. This study aimed to sort out the effect of obesity on anterior segment parameters. A study including 34 normal and obese subjects showed that ACV, ACA, and CCT were not significantly different between the groups, while the mean ACD in obese subjects was significantly lower than in control subjects, and ACD and ACA were negatively correlated with BMI [27]. We determined that the mean CCT, ACD, ACV, and ACA values were similar in obese and healthy pediatric individuals. A correlation analysis revealed no statistically significant influence of BMI, age, and sex for any measurements of anterior segment parameters in the control or obese groups. The limitations of this study were the mostly uniform ethnic group (Turkish), the relatively small number of cases, and the lack of axial length measurements.

In summary, these results may be beneficial in the clinical assessment of obese patients with additional ocular pathologies (e.g corneal diseases, glaucoma). Further studies comparing these parameters with that of obese patients are necessary.

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