Original Article / Özgün Araştırma

The Association Between Body Mass Index, Intraocular Pressure and Central Corneal Thickness in Children

Çocuklarda Beden Kitle İndeksi, Göz İçi Basıncı ve Santral Kornea Kalınlığı Arasındaki İlişki

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Keywords
Body mass index (BMI), central corneal thickness (CCT), children, intraocular pressure (IOP), non-contact air puff tonometer (NCT), obese, overweight

Anahtar Kelimeler
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Abstract

Objective: To compare intraocular pressure (IOP) and central corneal thickness (CCT) of normal, overweight, and obese children and evaluate the effects of body mass index (BMI) on IOP and CCT.

Materials and Methods: In this prospective, cross-sectional study, children aged 6 to 18 years without any ocular disease were included. IOPs and CCTs were measured with a non-contact air-puff tonometer (NCT) and optical coherence tomography (OCT), respectively. According to their BMI, children were divided into three groups as follows: group1 (normal), BMI ≤85; group 2 (over-weight), BMI 86-94; group 3 (obese), BMI ≥95. The IOP and CCT measurements of these groups were compared.

Results: Of all 73 patients (43 males, 30 females), 146 eyes were investigated in this study. The mean of IOP was 15±2.89, 16.50±3.10 and 19.50±4.15 mmHg in group 1 (n=62), group 2 (n=24) and group 3 (n=60), respectively (p<0.001). IOP was significantly higher in obese girls than in normal weight girls (20±3.82 mmHg, 15±2.50 mmHg, p<0.01). BMI and age had a significant effect on IOP (p=0.048 and p=0.025). A 1 standard deviation increase in BMI and age increased IOP of 0.175 and 0.187 mmHg, respectively.

Conclusion: In our study, IOPs measured with NCT were significantly higher in obese children, especially in girls, compared to normal and overweight children. Since the increase in intraorbital adipose tissue may lead to increased episcleral venous pressure resulting in increased IOP and impaired ocular perfusion, IOP measurements should be carefully evaluated in obese children.

Öz

Amaç: Normal, fazla kilolu ve obez çocukların göz içi basıncı (GİB) ve santral kornea kalınlığını (SKK) karşılaştırmak ve beden kitle indeksinin (BKİ) GİB ve SKK üzerindeki etkilerini değerlendirmek.

Gereç ve Yöntemler: Bu ileriye yönelik, kesitsel çalışmaya, 6-18 yaş arası, herhangi bir oküler hastalığı olmayan çocuklar dahil edildi. GİB'ler ve SKK'ler sırasıyla non-kontakt hava üflemeli tonometre (NKT) ve optik koherens tomografi (OKT) ile ölçüldü. Çocuklar BKİ'lerine göre üç gruba ayrıldı: grup 1 (normal), BKİ ≤85; grup 2 (fazla kilolu), BKİ 86-94; grup 3 (obez), BKİ ≥95. Bu grupların GİB ve SKK ölçümleri karşılaştırıldı.

Bulgular: Bu çalışmada 73 hastanın (43 erkek, 30 kadın) 146 gözü incelendi. GİB ortalamaları grup 1'de (n=62), grup 2'de (n=24) ve grup 3'te (n=60) sırasıyla 15±2,89, 16,50±3,10 ve 19,50±4,15 mmHg idi (p<0,001). GİB, obez kızlarda normal kilolu kızlara göre anlamlı olarak daha yüksekti (20±3,82 mmHg, 15±2,50 mmHg. p<0,01). BKİ ve yaşın GİB üzerinde anlamlı etkisi vardı (p=0,048 ve p=0,025). BKİ ve yaştaki 1 standart sapmalık artış, GİB'de sırasıyla 0.175 ve 0.187 mmHg'lik bir artışla sonuçlandı.
Sonuç: Çalışmamızda, obez çocuklarda, özellikle kızlarda NKT ile ölçülen GİB'ler normal ve fazla kilolu çocuklara göre anlamlı olarak daha yüksekti. Göz içi yağ dokusundaki olası artış, episkleral venöz basıncın artmasına neden olarak GİB'in artmasına ve oküler perfüzyonun bozulmasına neden olabileceğinden, obez çocuklarda GİB ölçümleri dikkatle değerlendirilmelidir.

Introduction

Obesity is becoming an important health problem due to reduced daily physical activity and changes in eating habits, especially in children, with effects on their adult lives. The coronavirus disease-2019 (COVID-19) pandemic in which people are stuck at home has also contributed to this problem recently. Considering that childhood obesity leads to a predisposition to many chronic diseases, the importance of studying the ophthalmologic effects of it is clear (1).

Recent studies have shown that obesity could be associated with increased intraocular pressure (IOP) (2). Increased IOP is the most important risk factor for primary open-angle glaucoma both for development and progression (3). It has been shown in adults that one of the independent risk factor for increased IOP is obesity. However, in children, the association between IOP and body mass index (BMI) is still controversial (4,5). So, we tried to investigate the association between BMI, IOP, and central corneal thickness (CCT) in children in this study.

Materials and Methods

This cross-sectional, prospective study was conducted after receiving the approval from the Aydın Adnan Menderes University Ethical Committee and Review Board in consistence with the Declaration of Helsinki, (decision no: 18 date: 05.03.2020).

All patients aged 6 to 18 years who were admitted to the Aydın Adnan Menderes University Ophthalmology Clinic between March and July 2020, without any ophthalmic pathology or systemic diseases like hypertension and diabetes mellitus were enrolled in this study. Visual acuity, slit-lamp anterior segment biomicroscopy, and fundoscopy examinations were performed. IOP and CCT measurements were made using a non-contact air-puff tonometer (NCT) (TONOREF II, Nidek, Tokyo, Japan) and optical coherence tomography (OCT) (Cirrus HD-OCT 500, Carl Zeiss, Dublin, LA), respectively. The patients weight is divided by the square of the height of the patients (kg/m^2) in order to calculate their BMI. Children were categorized as group1 (normal-weight; BMI ≤85), group 2 (overweight; BMI 86-94), and group 3 (obese; BMI ≥95) according to the Turkish percentile reference values (Olcay Neyzi percentile calculation system) (6).

Statistical Analysis

Before statistical analysis, to assess the assumption of normality of numeric variables the Kolmogorov-Smirnov test was performed. Continuous variables of the groups were shown as mean ± standard deviation and compared with one-way analysis of variance (ANOVA) and the Kruskal-Wallis H test. A chi-square test was used to compare categorical variables and expressed as numbers and percentages (%). A p-value of less than 0.05 was accepted as statistically significant.

Results

A total of 146 eyes of 73 children aged 6 to 18 years (43 male and 30 female) were evaluated in this study. Table 1 demonstrates the general characteristics, IOP, and CCT values of groups. No statistically significant correlation was detected between age and IOP or age and CCT (p=0.022, p=0.967). However, BMI and CCT were in a negative correlation with each other (r=0.146, p=-0.07) (Figure 1). CCT and IOP were found to have a positive correlation (r=0.246, p=0.03) (Figure 2). Furthermore, categorical regression analysis showed that age and BMI had a significant effect on IOP (p=0.048 and p=0.025, respectively). A 1 standard deviation increase in BMI and age resulted in 0.175 and 0.187 standard deviation increases in IOP, respectively. Female and male patients did not differ

Table 1. Demographic features, IOP, and CCT values of groups				
	Group 1 (n=62)	Group 2 (n=24)	Group 3 (n=60)	p-value
Mean age	12.5±3	13.2±3.1	13.5±2.6	0.158
Gender Male/female	30 (48.4)/ 32(51.6)	18 (75)/6 (25)	38 (63.3)/22 (36.7)	0.053
IOP (mmHg)	15.0±2.89	16.5±3.10	19.5±4.15	<0.001
CCT (µm)	550±14.9	566.5±15.7	551±17.3	0.053
IOP: Intraocular pressure, CCT: Central corneal thickness, n: Number				

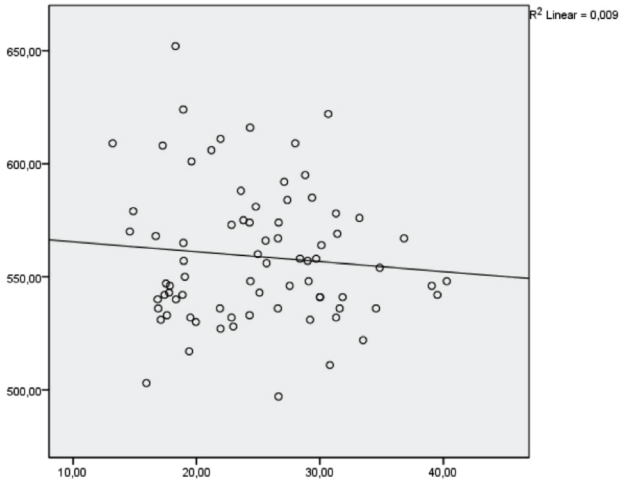

Figure 1. Negative correlation between BMI and CCT
BMI: Body mass index, CCT: Central corneal thickness

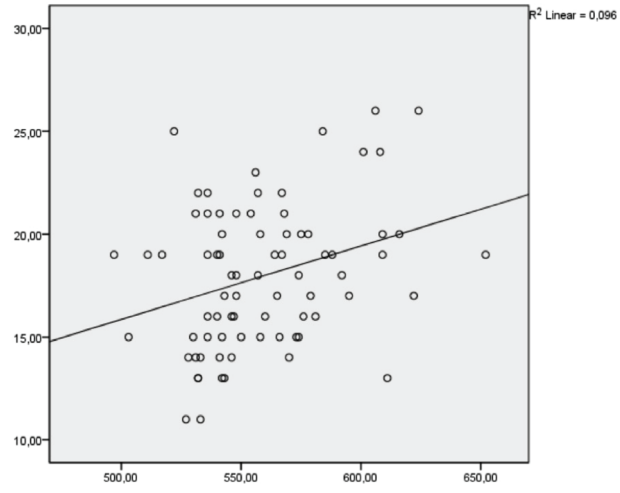

Figure 2. Positive correlation between CCT and IOP
CCT: Central corneal thickness, IOP: Intraocular pressure

in terms of CCT with each other statistically, but IOP and BMI were significantly higher in females than in male patients (p<0.001).

Discussion

Obesity is one of the most common chronic diseases in childhood (7). Understanding and investigating the correlation between childhood obesity and IOP may be important for early diagnosis and, more importantly, for the prevention of glaucoma in their later ages. The correlation between obesity and IOP has been reported in adults, but it is still controversial in children.

It has shown in adults that higher IOP is associated with obesity, BMI is an independent risk factor for increase in IOP, and IOP also decreases with weight loss (8). Moroever, studies investigating the effect of bariatric surgery on IOP have shown a significant reduction in IOP after surgery and subsequent rapid weight loss (9). There are some suggestions, in the literature, about the aetiology of increased IOP in obesity. Increased intra-abdominal pressure causes increased episcleral venous pressure or intraorbital adipose tissue contributes to the elevation of IOP by increasing episcleral venous pressure and decreasing aqueous outflow facility (10). Also, obesity related to hyperlipidemia might increase blood viscosity and excessive blood viscosity decreases the outflow capacity of episcleral veins, which can result in high IOP (11). Furthermore, analysis of serum leptin levels and leptin gene mutations have shown that there has been monogenic leptin deficiency in early childhood obesity, and recombinant leptin therapy might be a great choice for them (12). Leptin has a neuroprotective effect on a number of neurodegenerative diseases in the central nervous system (13). Glaucomatous neurodegeneration, similar to this neurodegenerative diseases. Therefore, leptin has proposed as a potential neuroprotective agent in the clinical management of glaucoma (14). Imparement of this leptin responce in obese children

may also contribute to development of glaucoma. In this prospective, cross-sectional study, the potential effect of BMI on IOP and the relation between CCT values of obese, overweight, and normal-weight children were investigated. Although CCT showed no significant difference among the groups, the mean IOPs of the obese children were significantly higher than the overweight and normal ones in our study. Our results, showing no significant differences in CCT, age, or sex among the groups, revealed that obesity alone might be a risk factor for increased IOP in children. A 1 standard deviation increase in BMI of the children resulted in an increase in IOP of 0.175 mmHg in our study. Similar to our result, some studies showed a positive correlation between BMI and IOP (15). Moreover, in the first study in the literature, Akinci et al. (5) reported a diurnal variation of IOP in obese children. However, in contrast to these reports, a few studies indicated no statistically significant association between IOP and BMI (16). These different results may be due to methodological variations in the studies, such as the instruments used for the measurement of the IOP, the determination of study groups, or a relatively small number of patients.

Another finding of our study was that the relationship between BMI and IOP was stronger in females compared to male patients. A positive correlation between BMI and IOP is more pronounced in female patients. Saguş Aydın et al. (4) reported a positive correlation between BMI and IOP in adults, finding that every 10 kg/m^2 increase would cause an IOP increase of 1.4 mmHg. Moreover, they also reported that this correlation was found to be more significant in female patients than in male patients, which is similar to our results in children. Estrogen could play a role on this result as it promotes collagen growth in cornea and sclera and this could alter the IOP levels in female (17). Anthropometric parameters differ among female and male children. It was shown that body composition especially fat mass/muscle mass ratio in females was significantly higher than those in males (18). A meta-analysis study suggested that greater fat mass has a higher risk of elevated IOP, notedly in females, and abdominal adiposity has a positive association with glaucoma (19). Adipose tissue also could play a role as an endocrine organ and synthesize sex hormones such as estrogen (20). In addition, estrogen may effect IOP; not only by influencing fat distribution but also by decreasing aqueous production and facilitating outflow systems in female patients (21).

There was a positive correlation between age and IOP. In our study, every 1 year increase in age caused an increase in IOP of 0.187 mmHg. While most studies in Western countries reported a positive association between age and IOP, Japanese researchers observed a negative association (22). In obese children, elevated IOP may not be diagnosed until optic nerve becomes evident. Therefore, IOP measurements in obese children should be repeated annually.

CCT is one of the most important factors affecting IOP measurements and the correlation between CCT and IOP has been well described; the thicker CCTs can cause false higher IOP readings (23). It was reported that CCT is also associated with higher BMI and metabolic syndrome. They suggested adults with a higher BMI have a thicker CCT and this increases IOP measurements. On the contrary, Sahinoglu-Keskek et al. (24) have showed a relationship between metabolic syndrome and higher IOP but not CCT in adults. There was no statistically significant difference among the groups in terms of CCT, in our study.

One of the limitations of our study is that IOPs were measured using a NCT instead of a Goldmann applanation tonometer, which is accepted as the gold standard for IOP measurement. During the procedure, compression of the chest or holding the breath may increase venous pressure, and applanation tonometry may cause false results in overweight patients (25). Second, IOPs were not measured at the same time interval of the day. Therefore, diurnal variation of IOP was not evaluated in our study.

Conclusion

Our study revealed that IOPs were significantly higher in obese children, especially females. BMI and age had a significant effect on IOP. Further studies with a larger sample size are needed.

Ethics

Ethics Committee Approval: This cross-sectional, prospective study was conducted after receiving the approval from the Aydın Adnan Menderes University Ethical Committee and Review Board in consistence with the Declaration of Helsinki, (decision no: 18 date: 05.03.2020).

Informed Consent: This cross-sectional, prospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: F.V., A.İ.A.Ü., T.Ü., A.A., Concept: A.İ.A.Ü., S.D., T.Ü., A.A., Design: A.İ.A.Ü., S.D., Data Collection or Processing: F.V., T.Ü., A.A., Analysis or Interpretation: A.İ.A.Ü., S.A.E., S.D., T.Ü., A.A., İ.K.Ö., Literature Search: F.V., S.A.E., Writing: F.V., A.İ.A.Ü., S.A.E., İ.K.Ö.

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