·Clinical Research·

Effects of body mass index on intraocular pressure and ocular pulse amplitude

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Abstract

• AIM: To investigate the effects of body mass index (BMI) on intraocular pressure (IOP) and ocular pulse amplitude (OPA).

• METHODS: Totally 140 healthy individuals without any systemic diseases were included in the study. BMI (kg/m2) was calculated for every individual. IOP and OPA were measured with Pascal Dynamic contour tonometer (DCT). Blood pressure was also measured along with the DCT. The patients were divided into three groups according to BMI as: Group1, BMI<25; Group2, 25≤ BMI<30; Group3, BMI≥ 30. Mean values of IOP, OPA, systolic blood pressure (SBP) and diastolic blood pressure (DBP) were used in statistical analysis.

• RESULTS: In Group1, the means of IOP, OPA, were 16.8± 2.3mmHg, 2.7± 0.7mmHg respectively; and SBP, DBP were 120.0 ± 6.1mmHg, and 77.4 ± 5.6mmHg respectively. In group2, the mean IOP, OPA, SBP, and DBP were found to be 16.6 ± 2.1mmHg, 2.4 ± 0.7mmHg, 121.7 ± 5.3mmHg, and 79.5 ± 4.9mmHg respectively. In group3, the mean IOP, OPA, SBP, and DBP were found to be 17.3 ± 1.7mmHg, 2.1 ± 0.7mmHg, 122.4 ± 5.7mmHg, and 79.7 ± 5.2mmHg respectively. There were no statistically significant difference between groups in terms of IOP, SBP and DBP, while OPA values were significantly lower in group3 (P=0.001).

• CONCLUSION: Decreased OPA values in individuals with higher BMI may indicate that subjects with higher BMI have lower choroidal perfusion and lower ocular blood flow.

• KEYWORDS: body mass index; choroidal perfusion; intraocular pressure; ocular pulse amplitude; obesity
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INTRODUCTION

Obesity is one of the most prevalent disorders in the world. It constitute an important risk for several diseases such as type 2 diabetes, hypertension, stroke, osteoarthritis, and sleep apnea syndrome [1]. Some eye diseases like cataract[2,3], glaucoma[4,5], diabetic retinopathy[6], and age-related macular degeneration [7,8] were reported to have potential relation to obesity.

In a considerable number of patients with glaucoma, progressive damage continues despite intraocular pressure (IOP) reduction with treatment [9]. Besides the increased IOP, there are several other factors associated with glaucoma progression such as neurotoxicity, reduced ocular blood flow[10-12], ocular vascular dysregulation[13] and changes in systemic blood pressure. [14,15]. Obesity possesses an increased risk for both elevated IOP [16-18] and systemic vascular abnormalities such as hypertension and arteriosclerosis [1]. Therefore obesity may play a role in glaucoma progression through elevated IOP and vascular dysregulation. Body mass index (BMI) is one of the most specific and objective measurement to define obesity.

Dynamic contour tonometer (DCT) (Pascal tonometer, Swiss Micro technology AG, Port, Switzerland) is one of the new contact tonometers, which was designed to perform measurements independent from biomechanic features of cornea [19]. It determines systolic and diastolic IOPs, and their differences, ocular pulse amplitude (OPA) [20]. OPA indirectly shows choroidal perfusion and ocular blood flow, which were suggested to be independent risk factors for glaucoma[20-22].

The purpose of this study is to investigate the relationship between body mass index and IOP, OPA measured with DCT.

MATERIALS AND METHODS

Subjects Totally 140 subjects without any known systemic diseases were included in this study. Subjects with

Table 1 Demographic data for each group

	Group1	Group2	Group3	*P* value
Number of participant	48	58	34	
Gender F/M	26/22	27/31	16/18	0.707
Age (year, average ±SD)	40.6±13.8	43.4±12.5	41.9±10.2	0.406
BMI (kg/m^2)	22.1±2.5	27.1±1.3	34.7±3.9	
IOP (mmHg, average ±SD)	16.8±2.3	16.6±2.1	17.3±1.7	0.124
OPA (mmHg, average ±SD)	2.7±0.7	2.4±0.7	2.1±0.7	0.001
SBP(mmHg, average ±SD)	120.0±6.1	121.7±5.3	122.4±5.7	0.124
DBP (mmHg, average ±SD)	77.4±5.6	79.5±4.9	79.7±5.2	0.081

BMI; Body mass index, IOP; Intraocular pressure, OPA; Ocular pulse amplitude, SBP; Systolic blood pressure, DBP; Diastolic blood pressure.

significant ocular disease that may affect the study results were also excluded from the study. Measurements from the right eye were used for statistical analysis. The study was performed according to the ethical principles of the Helsinki Declaration and approved by the institutional ethics committee. An informed consent was taken from all the subjects involved in the study.

BMI was calculated as weight in kilograms divided by the square of height in meters (kg/m^2). Subjects with BMI lower than 18.5 were labed as underweight, within the 18.5-24.9 range labeled as normal, within the 25.0-29.9 range labeled as overweight, and higher than 30.0 labeled as obese [23,24]. Because there were a few subjects in the low weight category, subjects in underweight and normal catagory (with 24.9 and lower BMI values) were combined to constitute Group1. Subjects labeled as overweight (between 25 and 30 BMI values) formed Group2, and subjects labeled as obese (with 30 and higher BMI values) formed Group3.

Methods IOP and OPA were measured with DCT under topical anesthesia. There is a quality grading for DCT measures. Based on this grading, score number 1 is identified as "the best," score number 2 and 3 are identified as "acceptable," and 4 and 5 are identified as "not acceptable" [22,25]. The measurements of IOP and OPA were taken on the same day between 8:00 am and 11:00 am by the same ophthalmologist. Mean IOP and OPA values were calculated after three consecutive measurements. The DCT measurements with quality 1 and 2 were taken into account. All measurements were performed by the same ophthalmologist (RK). In addition, blood pressures were also measured along with the DCT as obese subjects generally have higher blood pressures than nonobese subjects.

Statistical Analysis Due to the fact that the data distribution was not normal, a nonparametric test, Kruskal-Wallis test, was used to compare groups. In addition, Pearson correlation test was used to find out the correlations between parameters. SPSS 13.0 statistical package was used for statistical analysis. *P* values of less than 0.05 were considered to be statistically significant.

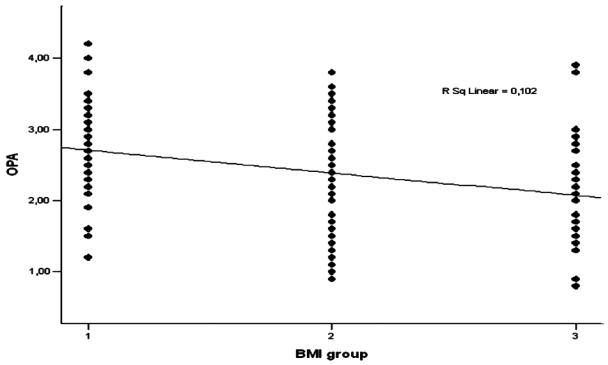

Figure 1 The values of OPA (Ocular Pulse Amplitude) measurements in BMI (Body Mass Index) groups.

RESULTS

The mean age of the subjects in Group1 was 40.6 ±13.8 years, 43.4±12.5 years in Group 2, and 41.9±10.2 years in Group3. Data for the age, gender, IOP, OPA, BMI, systolic and diastolic blood pressure of the subjects are presented in Table 1. There was no significant statistical difference between the groups in terms of age, gender, IOP, systolic and diastolic blood pressure (*P* value, 0.406, 0.707, 0.124, 0.124, 0.081 respectively). Mean of OPA was the lowest in group3 and highest in Group1. There was a significant statistical difference between the groups in terms of the mean OPA value (*P*=0.001) (Figure 1). In addition, a negative correlation was found between the OPA and BMI values (*P*=0.006, *r*= -0.231).

DISCUSSION

Obesity has been shown to cause vascular endothelial[26] and autonomic [27] dysfunction. Abnormal blood flow and unstable perfusion follow after autonomic and endothelial dysfunction [5,28,29]. Ocular blood flow decreases in patients with glaucoma [16] and OPA indirectly shows choroidal perfusion and ocular blood flow, which were considered as

independent risk factors for glaucoma [20-22]. We have found that OPA value was significantly lower in group3 while there was no statistically significant difference between the three groups in terms of IOP, systolic and diastolic blood pressure. This shows that ocular blood flow may also be disturbed in obese subjects and through altered ocular blood flow, as OPA decrease implies, obesity may accelerate glaucomatous damage.

Vulsteke *et al* [30] reported that the lower OPA value measured with dynamic contour tonometer was related to severe glaucomatous visual field defect, and defined lower OPA values as a risk factor for visual field defects. In the present study, we have found OPA value to be the lowest in group3 and the highest in group1. Therefore decreased OPA values in obese subjects may show that obese subjects with glaucoma were more liable to glaucomatous visual field defects than nonobese subjects without glaucoma.

Obesity has been reported to be an independent risk factor for high IOP and to have a positive relationship with IOP [9-11]. Increased intraorbital adipose tissue elevates episcleral venous pressure, and as a result, out-flow of aqueous humour is reduced. Besides, obesity increases blood viscosity through elevated blood cell count, hemoglobin and hematocrit. Therefore, resistance to out-flow increases in episcleral veins [9-11]. In these ways, ocular perfusion may decrease explaining the decrease of OPA in obese subjects. Furthermore, obesity is a risk factor for systemic hypertension [31]. Increased blood pressure increases ultrafiltration of aqueous humour by increasing ciliary artery pressure, and thus, IOP increases [32,33]. In the present study, there was no difference among the groups in terms of systolic and diastolic blood pressure. Analysis of IOP values between the groups was not statistically significant.

In conclusion, although subjects with different BMI have similar IOP, OPA values were lowest in the groupwith the highest BMI. Lower OPA values in obese subjects shows a tendency toward reduced ocular perfusion in these subjects. This may increase the vulnerability of obese people to glaucomatous injury in presence of high IOP. There is a need for future studies, which would categorize patients with glaucoma based on BMI, and would evaluate this in relation to OPA, visual field loss, and optic nerve morphologic values.

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