Correlative study of intraocular pressure and body mass index in North Indian subjects

Shikha Baisakhiya¹, Surjit Singh², Farah Mushtaq³

¹Assistant Professor, ²Professor, ³Resident, Department of physiology, Maharishi Markandeshwar institute of medical sciences and research, Mullana (Ambala).

ABSTRACT

Background: Various systemic and local factors affect IOP. Raised IOP is the major risk factor for development and progression of glaucoma. BMI is a modifiable systemic factor which can affect IOP. Aim: To find the correlation between IOP and BMI in adult North Indian subjects. Material and methods: The study included 300 healthy individuals. BMI was calculated by using Quetelet’s index i.e. Weight (in Kg)/ (Height (in m))^2. The intraocular pressure recording was done using Slit lamp mounted Goldman Applanation tonometer. According to BMI the subjects were divided into four groups viz. underweight with BMI < 18.5 Kg/m^2, normal weight with BMI 18.5 to 22.9 Kg/m^2, overweight with BMI 23 to 24.9 Kg/m^2 and obese with BMI > 25 Kg/m^2. Result: The mean IOP of underweight group was 14.72±2.37 mm of Hg. The mean IOP of normal weight group was 14.74 ±2.06 mm of Hg. The mean IOP of overweight group was 15.46±1.99 mm of Hg. The mean IOP of obese group was 17.9±2.54 mm of Hg. The IOP increased proportionately with increase in BMI. The difference was found to be statistically significant. Conclusion: We conclude that IOP is positively correlated with BMI. As raised IOP main risk factor for development of glaucoma so obesity is a risk factor for glaucoma. Periodic checking of IOP in obese individuals can lead to early diagnosis and prevent blindness due to glaucoma. Simple measures like dietary alteration, physical exercise and life style modification which can alter BMI can play an accessory role in prevention as well as treatment of glaucoma.

KEYWORDS: IOP and BMI, obesity, obesity and glaucoma

INTRODUCTION

The World Health Organization has described obesity as one of today’s most neglected public health problems, affecting every region of the globe. As per W.H.O. world health statistics 2012 report one in six adults is obese and one in three has a raised blood pressure.[1] International Obesity Task Force estimates suggest that 1.1 billion people are overweight worldwide, and 312 million of them are obese.[1,2] Obesity is on the top of cluster of non-communicable diseases creating enormous socioeconomic burden globally. It is the risk factor for various systemic diseases like hypertension, diabetes, osteoarthritis and sleep apnea syndrome.[3]

Various ocular diseases like glaucoma, ARMD, benign intracranial hypertension and diabetic retinopathy are also more preponderant in obese individuals. Metabolic syndrome a cluster of coexistent abnormalities like hypertriglyceridemia, hyperglycemia, hypertension and obesity is associated with elevated IOP. Independently raised IOP is associated with each component of metabolic syndrome.[4, 5]

Glaucoma is the second largest cause of irreversible blindness in the world. Intraocular pressure is the proven as the most significant factor contributing to development and progression of glaucoma. With the currently available treatment modalities it is the only risk factor that is modifiable.[6] But in spite of reduction of IOP by currently available modalities progression of glaucoma continues. Therefore apart from IOP factors like neurotoxicity, blood flow to the optic nerve also play a role in disease progression. Regulation of blood flow to the optic nerve is
indirectly dependent on systemic blood pressure.[7] Obesity is a risk factor for both raised IOP and blood pressure. Although the key risk factor in glaucoma is raised IOP the severity and degree to which the associated risk factors are present can alter the course and prognosis of the disease. Simple measures like dietary alteration, physical exercise and lifestyle modification which can alter BMI can play an accessory role in prevention as well as treatment of glaucoma. Hence we conducted this study to find the relationship between IOP and BMI in turn to find the relationship between glaucoma and obesity.

AIM AND OBJECTIVE: To find the correlation between IOP and BMI in adult population of North India.

MATERIALS AND METHODS
The study was conducted in department of physiology MMIMSR. A group of 300 healthy individuals between 40-79 years of age were included in the study. Subjects having any chronic systemic or ocular disease were excluded from the study. Subjects on any chronic systemic or ocular medication were also excluded. On the basis of BMI subjects were divided into four categories i.e. underweight, normal weight, overweight and obese as per revised body type classification for Indian population recommended by Ministry of Health and Diabetes foundation of India.[8] The BMI in the four categories were as follows

1. Underweight: BMI < 18.5 kg/m²
2. Normal weight: BMI 18.5 kg/m² - 22.9 kg/m²
3. Overweight: BMI 23 - 24.9 kg/m²
4. Obese: BMI > 25 kg/m²

A detailed personal history including name, age, sex, occupation and habits was taken from the patient. History of any past illness and chronic medication was obtained. Family history of diabetes, hypertension and glaucoma were excluded. Physical examination of the subjects included height (in meter) and weight (in kilogram). Height and weight was recorded in light clothing without shoes and in standing position. BMI was calculated by using Quetelet’s index i.e. Weight (in kg) / (Height (in m))². [8] The ocular examination included visual acuity, slit lamp biomicroscopy and examination of optic disc using direct ophthalmoscope. The intraocular pressure recording was done using Slit lamp mounted Goldmann Appplanation tonometer. To avoid the effect of diurnal variation IOP record was done between 10-11 AM.

RESULTS
The number of subjects in underweight group was 23 (7.7%) with 18 females and 5 males. The total number of subjects in normal weight was 84 (28%) with 49 females and 35 males. The total number of subjects in overweight group was 69 (23%) with 27 females and 42 males. The total number of subjects in obese group was 124 (41.3%) with 64 females and 60 males. (Table 1) The mean IOP of underweight group was 14.72±2.37 mm of Hg. The mean IOP of normal weight group was 14.74 ±2.06 mm of Hg. The mean IOP of overweight group was 15.46±1.99 mm of Hg. The mean IOP of obese group was 17.9±2.54 mm of Hg. The IOP increased proportionately with increase in BMI.

The difference was found to be statistically significant. (Table 2) The IOP was compared between the groups and within the groups applying ANOVA and the change was found to be significant (p<0.001). (Table 3) On multiple comparisons applying POST HOC test the difference in IOP between underweight and obese, normal weight and obese and overweight and obese was highly significant. (p<0.001)(Table 4) The correlation between IOP and BMI was studied using Pearsons correlation and a positive correlation was seen between the two variables (p<0.001). (Table 5).

Table 1: Distribution of study subjects according to their BMI

<table>
<thead>
<tr>
<th>BMI Group</th>
<th>Male (%)</th>
<th>Female (%)</th>
<th>Number (% of total )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>21.7</td>
<td>78.2</td>
<td>23(7.7%)</td>
</tr>
<tr>
<td>Normal weight</td>
<td>41.67</td>
<td>58.33</td>
<td>84(28%)</td>
</tr>
<tr>
<td>Overweight</td>
<td>60.86</td>
<td>39.14</td>
<td>69(23%)</td>
</tr>
<tr>
<td>Obese</td>
<td>48.39</td>
<td>51.61</td>
<td>124(41.3%)</td>
</tr>
</tbody>
</table>

Table 2: IOP levels in study subjects with different BMI

<table>
<thead>
<tr>
<th>Category</th>
<th>Number (% of Total)</th>
<th>Mean IOP±SD (mm of Hg)</th>
<th>Minimum IOP (mm of Hg)</th>
<th>Maximum IOP (mm of Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>23( 7.7%)</td>
<td>14.72±2.37</td>
<td>10.5</td>
<td>20.0</td>
</tr>
<tr>
<td>Normal weight</td>
<td>84 (28%)</td>
<td>14.74±2.06</td>
<td>10.0</td>
<td>19.5</td>
</tr>
<tr>
<td>Overweight</td>
<td>69 (23%)</td>
<td>15.46±1.99</td>
<td>11.0</td>
<td>19.5</td>
</tr>
<tr>
<td>Obese</td>
<td>124(41.3%)</td>
<td>17.90±2.54</td>
<td>11.0</td>
<td>23.0</td>
</tr>
</tbody>
</table>
### Table 3: Statistical comparison of IOP with BMI (ANOVA TEST)

<table>
<thead>
<tr>
<th></th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>625.470</td>
<td>3</td>
<td>208.490</td>
<td>40.079</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Within groups</td>
<td>1539.800</td>
<td>296</td>
<td>5.202</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2165.270</td>
<td>299</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 4: Statistical comparison of IOP with BMI in the four groups (POST HOC TEST)

<table>
<thead>
<tr>
<th>BMI groups (I)</th>
<th>BMI groups (J)</th>
<th>Mean difference (I-J)</th>
<th>Standard. error</th>
<th>Sig.</th>
<th>Lower bound (95% confidence interval)</th>
<th>Upper bound (95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>Normal weight</td>
<td>-.0207</td>
<td>.5368</td>
<td>1</td>
<td>-1.446</td>
<td>1.405</td>
</tr>
<tr>
<td></td>
<td>overweight</td>
<td>-.7464</td>
<td>.5492</td>
<td>1</td>
<td>-2.205</td>
<td>.712</td>
</tr>
<tr>
<td></td>
<td>Obese</td>
<td>-3.1818(*)</td>
<td>.5178</td>
<td>&lt;.001</td>
<td>-4.557</td>
<td>-1.806</td>
</tr>
<tr>
<td>Normal weight</td>
<td>Under weight</td>
<td>.0207</td>
<td>.5368</td>
<td>1</td>
<td>-1.405</td>
<td>1.446</td>
</tr>
<tr>
<td></td>
<td>overweight</td>
<td>-.7257</td>
<td>.3706</td>
<td>.307</td>
<td>-1.710</td>
<td>.259</td>
</tr>
<tr>
<td></td>
<td>obese</td>
<td>-3.1611(*)</td>
<td>.3223</td>
<td>&lt;.001</td>
<td>-4.017</td>
<td>-2.305</td>
</tr>
<tr>
<td>Over weight</td>
<td>Underweight</td>
<td>.7464</td>
<td>.5492</td>
<td>1</td>
<td>-.712</td>
<td>2.205</td>
</tr>
<tr>
<td></td>
<td>Normal weight</td>
<td>.7257</td>
<td>.3706</td>
<td>.307</td>
<td>-.259</td>
<td>1.710</td>
</tr>
<tr>
<td></td>
<td>obese</td>
<td>-2.4354(*)</td>
<td>.3426</td>
<td>&lt;.001</td>
<td>-3.345</td>
<td>-1.526</td>
</tr>
<tr>
<td>Obese</td>
<td>underweight</td>
<td>3.1818(*)</td>
<td>.5178</td>
<td>&lt;.001</td>
<td>1.806</td>
<td>4.557</td>
</tr>
<tr>
<td></td>
<td>Normal weight</td>
<td>3.1611(*)</td>
<td>.3223</td>
<td>&lt;.001</td>
<td>2.305</td>
<td>4.017</td>
</tr>
<tr>
<td></td>
<td>Overweight</td>
<td>2.4354(*)</td>
<td>.3426</td>
<td>&lt;.001</td>
<td>1.526</td>
<td>3.345</td>
</tr>
</tbody>
</table>

*The mean difference is significant at .001 level

### Table 5: Correlation between IOP and BMI (Pearson correlation)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>IOP</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOP</td>
<td>Pearson correlation</td>
<td>.551(*)</td>
</tr>
<tr>
<td></td>
<td>Sig (2 tailed)</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>300</td>
</tr>
<tr>
<td>BMI</td>
<td>Pearson Correlation</td>
<td>.551(*)</td>
</tr>
<tr>
<td></td>
<td>Sig (2-tailed)</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>300</td>
</tr>
</tbody>
</table>

*Correlation is significant at 0.01 level (2 tailed)

### DISCUSSION

In our study the IOP increased proportionately with increase in BMI. The relationship was statistically significant (p<0.01). On multiple comparisons it was found that a rise in IOP in obese subjects was highly significant as compared to underweight, normal and overweight individuals (p<0.001). Although the difference in IOP between underweight and normal weight, normal weight and overweight and underweight and overweight was not significant statistically. Lee JS et al in their study on Korean population found that the “systolic and diastolic hypotensive lean” have lower IOP as compared to “systolic and diastolic hypertensive obese” individuals. [5] Mori K et al in their study on Japanese population concluded that obesity is an independent risk factor raised IOP. [9] Shriela Pie et al in their study on south Indian population found that subjects with higher BMI had higher IOP. [10] Central India eye study by Nangia V et al the study was conducted on 3373 subjects the IOP was significantly positively correlated with high systolic blood pressure, diastolic blood pressure as well as higher body mass index.[11] Our findings were in accordance with these studies.

Karadag et al in their study found a decreased OPA (Ocular pulse amplitude) values in individuals with higher BMI. The decrease in OPA indicates that subjects with higher BMI...
have lower choroidal perfusion and lower ocular blood flow. [12] Sacca SC et al concluded that oxidative stress associated with obesity has been postulated in the pathogenesis of primary open angle glaucoma. Hyperlipidemia often associated with obesity may cause an increase in oxidative stress. [13] The possible association of raised IOP with rising BMI could be attributed to deposition of excess intraorbital fat leads to increase in episcleral venous pressure and consequently decrease in outflow facility. [14] Increase in blood viscosity through increased red cell count, hemoglobin, hematocrit and increasing resistance to outflow. [15] Exaggerated dynamic cortisol response due to increased activation of 11β HSD enzyme. Increased cortisol activity in obese individuals lead to increased IOP by decreasing the aqueous outflow facility. [16] Hence the combined evidence from various studies suggest that increased BMI or obesity is an independent risk factor for raised IOP and hence glaucoma. The findings of our study reaffirm the same.

CONCLUSION
From the observation of our study it is concluded that IOP is positively correlated with BMI. As raised IOP main risk factor for development of glaucoma so obesity is a risk factor for glaucoma. Periodic checking of IOP in obese individuals can lead to early diagnosis and prevent blindness due to glaucoma.

REFERENCES

*Corresponding author: Dr Shikha Baisakhiya
E-Mail: nitishikha2478@rediffmail.com