ORIGINAL ARTICLE

The Association of Cigarette Smoking on Intraocular Pressure Among Young Adult Male: a Preliminary Study

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ABSTRACT

Introduction: Nicotine administration can cause changes to the aqueous humour resistance, which could influence the intraocular pressure (IOP). This preliminary study is designed to determine the difference and association of IOP in a sample of young adult smokers and non-smokers in Selangor. **Methods:** Healthy young adult males between 18 and 35 years old who are non-alcoholic and without ocular and systemic diseases were recruited in this study. Smokers were classified into light smokers, moderate smokers, and heavy smokers based on the smoking index. The IOP was measured using Goldmann applanation tonometer on each eye .**Results**: The analysis involved a total of 34 young adult males (mean age: 23.29 ± 2.19 years), with 17 (50%) smokers and 17 (50%) non-smokers. For smokers, the median IOP value was statistically higher (16.00 (1.8) mmHg), than non-smokers (11.70 (1.0) mmHg) ($p < 0.001$). All smokers were found to be light smokers; light smokers SI 0-50 and light smokers SI 51-100 showed no significant difference on IOP. Spearman's correlation indicates a moderate positive correlation between the IOP of both eyes to the smoking index, with rs= 0.46 ($p = 0.006$) **Conclusion**: This study exemplified a higher IOP among smokers and moderate positive association of smoking index to the IOP among healthy young adults, even for those with a brief history of smoking.
Keywords: : Intraocular pressure, Smokers, Light smokers, Smoking index

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INTRODUCTION

There are series of anti-smoking policy measures has been implemented for over ten years in Malaysia which involves prohibition of Tobacco advertisement, enactment of anti-smoking campaign such as "Tak Nak", designation of smoke-free areas, and restructuring of Tobacco taxes (1). Even so, the prevalence of smoking has shown only modest decrement by only 2.8% (1996-2006) as compared to the other countries (9% to 25%) of 10-20 years anti-Tobacco policies. This has put on a great concern, as it will remain the key contributor to untimely morbidity and mortality (1), namely respiratory, cardiovascular, and malignant diseases in Malaysia. Smoking has also been linked as one of the many external contributing factors to numbers of ocular disease, namely, Graves' eye disease, age-related macular degeneration, cataract, as well as glaucoma (2).

In glaucoma, high intraocular pressure (IOP) is the established modifiable risk factors that cause progressive optic neuropathy and visual field defect, resulting in irreversible visual impairment if left untreated. The optimum IOP within the normal physiological range is vital in regulating the anatomical conditions inside the eyes. Intraocular pressure is regulated via the equilibrium of aqueous humour production and aqueous humour excretion from the anterior chamber space (3). As the production of aqueous humour remains normal on the glaucomatous eye, the most common reason for high IOP is due to reduction of its drainage (4). Nicotine administration might cause impeded outflow of aqueous humour to trabecular meshwork and highly resistant through increased blood viscosity and induced

vasospasm in ophthalmic artery blood flow (5,6). Nicotine constituent in cigarette also stimulates the generation of free radicals and lowers the amounts of antioxidants in the blood circulation, aqueous humour, and ocular tissue (2).

A number of previous studies had investigated the association between intraocular pressure and cigarette smoking. Positive association had been postulated, which showed higher intraocular pressure among smokers in Western population (5,7,8) and Asian population (9,10), yet there are few such studies in Southeast Asia and none in Malaysia. Additionally, the population-based study conducted in Asia used non-contact tonometer, which might be less precise than the Goldmann applanation tonometer (9). Most of the subjects used were also hospital patients, which could imply that the elevated intraocular pressure might be due to underlying diseases or age of the subjects; as they tend to have a hospital visit for an annual health check-up compared to healthy younger people. Many studies have yet to classify smokers using the smoking index, which could not well explained the chronic smokers that is determined by the number of pack years (5,7). Hence, this preliminary study was undertaken to determine the differences of intraocular pressure among a smokers and non-smokers subjects, and its relationship in young adult male in Shah Alam, Selangor, Malaysia.

MATERIALS AND METHODS

This study was approved by Research Ethics Committee, Management and Science University (code ethics no: MSU-RMC-02/FR01/05/L2/030) and was conducted in the Management and Science University Eye Centre (MEC), Selangor, Malaysia. Young adult males are recruited after their consent are obtained to participate in this study. Based on G-power analysis (11), a total number of 12 subjects; 6 subjects from each smokers and non-smokers group, are required in this study (pre-determined mean and standard deviation for smokers and non-smokers were 16 mmHg and 2 mmHg, and 12 mmHg and 1 mmHg respectively, an alpha level of 0.05 and a power of 0.95).

Smokers are defined by current smokers who have had the history of smoking continuously for one month. The inclusion criteria for this study were young adult male aged between 18–35 years. Subjects who are non-alcoholic with previous eye surgery, severe ocular trauma in past, inflammatory eye conditions, diabetic, alcoholic, hypertension, obesity, glaucoma, use of diuretics or beta blockers, and contact lens wearer were excluded from this study. The data collection was taken between 8.00 AM–12.00 PM to avoid variation of IOP due to diurnal variation.

History taking was done to extract information about a subject's age, race, medical history, social history, and smoking habit in terms of number of cigarettes smoked, duration of smoking (number of years), exposure, and brand of cigarette. Smoking index (SI) was calculated by using the formula: smoking index = number of cigarettes smoked in a day x number of years (6). Smokers were further classified based on their SI, in which 1–100 refer to light smokers, 101–200 to moderate smokers, and more than 300 to heavy smokers (6). The intraocular pressure (IOP) was measured using Goldmann applanation tonometer (GAT) on each eye as GAT was considered as gold standard for measuring IOP. Subject's eyes were anaesthetised using Alcaine® and fluorescein, which were inserted prior to proceeding with the GAT procedure. Three IOP readings were measured from both eyes and the average value was recorded for analysis.

Statistical analysis of the data collected in this study was performed using SPSS version 24.0. The normality of data was tested using Shapiro–Wilk test and it is discovered that the data was not normally distributed, hence non-parametric tests were used to analyse the data. Simple descriptive statistical methods were used to describe numerical data of the sample, presented as mean (standard deviation) or median (interquartile range). Frequency and percentage were used to present categorical values. A comparison of variables between smokers and non-smokers, and among smokers group performed using the Mann-Whitney test, while Spearman's correlation was used to assess the relationship between smoking index and intraocular pressure. The p-value less than 0.05 was considered as statistically significant.

Table l : Description of subjects

	Mean (±SD)	Frequency (%)
1. Age	23.29 ± 2.19 years	
Smokers (n=17)	23.41 ± 1.64 years	
Non-smokers (n=17)	23.18 ± 2.70 years	
2. Race		
Malay		27 (79%)
Indian		4 (12%)
Chinese		3 (9%)
3. Smoking Index (smokers)	75.26 (± 23.18)	

RESULTS

A total number of 40 healthy young adult males participated in this study. Among all the subjects, two were outside the age requirement (young adult 18-35 years old) and four had an incomplete history of smoking, to which they were excluded from the study. A total of 34 subjects aged between 19 to 27 years were further

analysed, of which 17 (50%) of them were smokers and 17 (50%) of them were non-smokers. Table I shows the detailed description of the subjects in this study.

The median IOP value for right eye and left eye were 13.15 (4.8) mmHg and 13.85 (4.3) mmHg, respectively, with a strong correlation of IOP between right eye and left eye ($r = 0.835$, $p < 0.001$). Hence, only right eye is taken for further analysis. Table II depicts the comparison of intraocular pressure in both smokers and non-smokers group. The median IOP of smokers is statistically higher than non-smokers, with $p < 0.001$, 95% CI 6.00–16.00.

Table II : Comparison of IOP between smokers and non-smokers

IOP	Median (interquartile range)	p-value
Smokers (n=17)	16.00 (1.8) mmHg	< 0.001
Non-smokers (n=17)	11.70 (1.0) mmHg	

Initially, smokers' group were divided into light smokers, moderate smokers, and heavy smokers based on their smoking index. Due to the limitation of duration and small sample size, all smokers were found out to be light smokers. Hence, they were further classified into light smokers with SI between 0–50 and light smokers with SI between 51–100 to oversee any difference between the subgroups of light smokers. Table III shows the description of each classification. SI 51–100 has a significant higher smoking index, compared to SI 0–50 ($p<0.001$). There was a trend that smoking index 51–100 showed higher IOP for both eyes, compared to smoking index 0–50, yet it is deemed statistically insignificant (Table III).

Table III : Comparison of IOP among light smokers

	SI 0-50	SI 51-100	p-value
Mean SI*	45.00 (±8.36)	89.23 (±10.37)	p<0.001
Range SI	30-50	80-100	
Frequency (%)	5 (29.4%)	12 (70.6%)	
IOP**	15.65 (1.6) mmHg	16.50 (1.0) mmHg	0.33

*Data expressed as mean (standard deviation)
**Data expressed as median (interquartile range)

Spearman's correlation test was used to observe the relationship between smoking index on intraocular pressure. The results of Spearman's rho indicated the presence of a moderate positive correlation between IOP and smoking index with $rs(8) = 0.461$ ($p = 0.006$) (Table IV).

Table IV: Association between smoking index and intraocular pressure.

		IOP
Smoking Index	Spearman's rho correlation coefficient	0.46
	Sig. (2-tailed)	0.006
	N	34

DISCUSSION

The IOP value for healthy young adult in this study is within the normal value of 10–21 mmHg (6). Aging caused distribution of IOP tend to be lowest in their 20s and 60s, by which it increases when one reaching their 50s and decreases as reaching their 60s, according to one retrospective cross-sectional study on Korean population (10). Healthy young adult was chosen to eliminate the influence of age- and systemic-related problems on intraocular pressure, whereby this study documented a younger age group of smokers compared to previous study. In this study, young smokers were reported to have higher IOP on both eyes as compared to that of non-smokers. This result is in accordance with previous population-based studies done on Western (7,8) and Asian population (9,10) although it contradicts a few cross sectional studies (8,10-11).

One recent study opposes the association of smoking and intraocular pressure as the study reported no significant difference of intraocular pressure between smokers and non-smokers. They postulated that since there was no nicotinic receptor at the ciliary body/ciliary processes/ciliary epithelium, hence, there was no nicotine effect from the tobacco on the production site of the aqueous humour (6). In contrast, study done by Timothy et. al, (2012) on normotensive male young adult, there were significant elevation of IOP, arterial blood pressure, and systolic blood pressure after being induced with cigarette inhalation of two sticks per day in three-hour interval for one month. One possible explanation was that there is an increase of blood viscosity by which the haemorheological parameters inconjunct with smoking. This leads to reduction of blood flow in the peripheral ocular circulation and increment in the outflow resistance of the aqueous humour (9). Hence, a cigarette smoker eventually may be put at risk whether in acute or chronic condition of ocular disorders (12). Due to variation of findings in previous literatures it is imperative to conduct a more detailed study for a better conclusive data.

Smoking-induced blood hyperviscosity is seen over long duration of smoking, which is only demonstrated by heavy smokers (6). The chronic degenerative changes in blood vessel of small arteries lead to an elevation of blood pressure, followed by the raise in intraocular pressure due to increased ultrafiltration (6).

All smokers in this study were found to be light smokers Nevertheless, light smokers demonstrated significantly higher IOP, compared to non-smokers. Further analysis on light smokers subcategory showed insignificant higher IOP among light smokers with low SI (0–51) to light smokers with high SI (51–100), and a significantly moderate positive correlation between smoking index and IOP of both eyes ($p < 0.05$). This study adopted the classification of smoking intensity based on smoking index, as compared to previous study which used the status of never smokers, ex-smokers, and smokers. The latter classifications could mask the effect of chronic long-term habits of smokers, which is defined by the number of packs and years (5).

Many studies have attempted to establish the effect of smoking on intraocular pressure, yet the results are conflicting (13). This might be due to the different methods used to measure the IOP and different classification of smokers used in the sampling method. This study counts monocular IOP to rule out the possibility of asymmetry IOP between eyes. This preliminary study contributes to the knowledge of the association of smoking history to intraocular pressure among young adult smokers in Malaysia. Although all subjects recruited in this study are free from any systemic disease, the inclusion of vital measurements such as systolic blood pressure and diastolic blood pressure would be beneficial in future studies to avoid any bias. A pre and post IOP measurement after induced smoking would be meaningful to test the hypothesis. Future research with larger sample size also is recommended, in which significant samples of smokers with different SI, types of smoking, and age group may lead to obtaining significant findings.

CONCLUSION

This study exemplified the higher intraocular pressure among smokers and moderate positive association of smoking index to intraocular pressure among healthy young adults, even those with a brief history of smoking. Although inconclusive, smoking does cause some changes in intraocular pressure, which could aggravate the changes of ocular blood circulation and resistance of aqueous humour outflow.

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