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Research Article

The Effect of Caffeine on Intraocular Pressure among Young Healthy Saudi Subjects

Alotaibi WM[1]* and Yara Almaiman[1]

[1]*Department of Optometry and Visual Sciences, King Saud University, Riyadh, Saudi Arabia*

***Corresponding author:** Alotaibi WM, Assistant Professor, Department of Optometry, King Saud University, College of Applied Medical Sciences, Kingdom of Saudi Arabia.

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Abstract

Purpose: To investigate the effect of caffeine intake on intraocular pressure (IOP) among young Saudi healthy subjects by using gold standard tonometry.

Method: A total of 60 subjects (45 females and 15 males) participated in this prospective cross-sectional study. Subjects were aged between 18 and 27 years, they were recruited from King Saud University (KSU), Saudi Arabia. All subjects had normal ocular surface, spherical equivalent < ±4.00DS, free from systemic diseases. Subjects fasted from caffeine for at least 24 hours and discontinued wearing contact lenses for three days before the IOP test. Measurements of IOP were taken for at least four hours from waking up. IOP was taken at baseline by using Goldmann applanation tonometry, then the subjects drank a cup of coffee that contains 240mg of caffeine. The second measurement was taken at sixty minutes later. For statistical analysis, Paired t-test was used, and p-value<0.05 considered significant.

Result: The results showed that a single cup of coffee that contains 240mg of caffeine significantly increase IOP after 60 minutes. The mean difference in female was (1.78mmHg, p-value <0.0001), in male was (1.81mmHg, p-value <0.0001), and was (1.79mmHg, p-value <0.0001) when total subjects considered.

Conclusion: The IOP increased significantly after drinking a cup of coffee in normal subjects, which is very vital and calls for more public awareness. Thus, we recommend further research to study the effect of caffeine on ocular hypertension and glaucoma patients.

Background

Caffeine (1,3,7-Trimethylxanthine) could be found in many sources of food or drinks in varying concentrations such as coffee, tea, soft drinks, energy drinks, and chocolate [1]. Coffee has become widely consumed in high concentrations, 35mg to 175mg of caffeine per cup, in young adults especially student to promote alertness [2]. Caffeine affects the Nervous System by binding and inhibiting adenosine receptors [3]. Also, it affects the Sympathetic Nervous System (SNS) that has multiple effects on different systems of the body such as the cardiovascular system by increasing the heart rate and blood pressure [4] Moreover, it affects many ocular structures of the eye, such as raising the level of intraocular pressure (IOP) especially in glaucoma patients, thus lead to optic neuropathy and blindness [5-11]. According to World Health Organization (WHO), glaucoma is the second leading cause of blindness worldwide, 4.5 million people have been estimated to be blind due to glaucoma, which accounts for 12% of global blindness [12].

Maintaining the IOP within the normal range (10-21mmHg) is necessary for the health of the eye. There are several factors affect the level of IOP including sex, age, ethnicity [13-15] refractive error [16, 17] and caffeine [5-11]. The measurement of the

IOP is obtained by the use of tonometry. There are two types of tonometry: Applanation and Indentation tonometry. Applanation tonometry is divided into contact and non-contact methods [18]. In this study we used the contact method by Goldmann applanation tonometer which is a 3.06 mm diameter cone mounted in slit-lamp and apply in the central surface of the cornea. It forms a force that is necessary to flatten the cornea and counterbalanced the resistance by the capillary attraction of the tear film meniscus. It requires installation of anesthesia and fluorescein dye drop. Goldmann applanation tonometer is considered a gold standard of tonometry [18]. As we mentioned previously, there are several factors affect the level of IOP. A study conducted by Nannini, et al. [13] examined the relationship between genetic ancestry and IOP in Latinos. They recruited 3541 participants from the Los Angeles Latino Eye Study (LALES). The author found that African race was significantly associated with higher IOP even after the confounding factors adjusted like age, gender, body mass index, systolic blood pressure, central corneal thickness, and type 2 diabetes, the association remained significant. Baek, et al. [14] assessed the changes of IOP with age in South Korea. There were 31,857 participants enrolled in this study. The authors concluded that IOP was significantly increased with age, although the amount of change was small. Men and young age groups had lower IOP than women and older age groups. Manny, et al. [16] conducted a cohort study to investigate the associations among IOP, ethnicity, and refractive error in 3,777 children. The children were aged between 6-14 years old. The author demonstrated that children with low/moderate myopia had higher IOP than those with high hyperopia, differences <1 mm Hg) the difference was small but statically significant. Our review of literature found serval studies that was designed to determine the effect of caffeine on IOP. A recent study done by Nwosu, et al. [5] designed a prospective, observer-masked, cross-over study to determine the effect of caffeine on IOP in normal individuals. This study revealed a significant rise in IOP in normal subjects and this increase was dose dependent.

Also, Jiwani, et al. [6] have done a prospective, double-masked, crossover, randomized controlled trial (RCT) study to examine the effect of caffeinated coffee on IOP in patients with or at risk of open angle glaucoma (OAG) and in normal individuals. They found that the IOP increased significantly after 60 minutes of coffee drinking in all groups. Furthermore, Li, et al. [8] have done systematic review and meta-analysis study to investigate the effect of caffeine intake on IOP in normal individuals and in patients with glaucoma or ocular hypertension (OHT). The evidence revealed that caffeine had different effects on IOP in different groups of individuals. For normal individuals, IOP was not changed by ingestion of caffeine, while for patients with glaucoma or OHT, IOP increased significantly. Moreover, Chandrasekaran, et al. [9] study was designed to investigate the relationship between caffeine consumption and IOP using a large cross-sectional population-based study Blue Mountains Eye Study (BMES). The authors examined 3654 participants. They found that there is a positive cross-sectional association between caffeine intake and IOP. We were unable to retrieve a study that reported the effect of caffeine in Saudi population. Since coffee is most preferred drink in Saudi Arabia, therefore, we aim in this study to investigate the effect of caffeine intake on IOP among young Saudi healthy subjects by using gold standard tonometry. The importance of this study in clinical implications, it could raise the awareness in designing the caffeine diet to control the IOP level in glaucoma patients.

Methods

This is a prospective cross-sectional study conducted in optometry clinics at king Saud university in Riyadh, Saudi Arabia, from October 2019 to January 2020. It was performed in accordance with the tenets of the Declaration of Helsinki [19] regarding research involving human subjects. The study was approved by the ethical committee at King Saud University Medical City (ethics number E-20-4541) and the informed consent was obtained from the participants included in the study. Sixty healthy young Saudi subjects aged between 18 and 27 years old, without ocular or systemic diseases and have normal IOP between 12-21 mmHg were included in this study. The participants were asked to fast from caffeine for at least 24 hours and discontinue wearing contact lens for three days before the IOP test. Measurements of IOP were taken for at least four hours from waking up. Any subjects have ocular abnormalities or history of ocular surgery and spherical equivalent > ±4.00D were excluded. We also exclude subjects who had family history of glaucoma or take any type of medication. Pregnant women were also excluded. All subjects received a full eye examination by one examiner. Screening tests were performed for each subject to exclude any subject has ocular abnormalities or has refractive error > ±4.00D. The tests include refraction by autorefraction (Topcon KR-1 Autorefractor/Keratometer), anterior segment eye examination by slit lamp (Haag-Streit BQ 900 Slit Lamp) and IOP measurement by Goldmann applanation tonometry (Haag-Streit BQ Slit Lamp Tonometer). The IOP was measured by one well trained examiner. Ocular anesthesia drops (Oxybuprocaine hydrochloride 0.4%) applied on both eyes of the participant and waited 10 minutes for effect, isopropyl alcohol 70% (methylated spirit) was used to disinfect the cone of the Goldmann applanation tonometry. Then, Fluorescein sodium 2% was applied to the eye. Wide cobalt blue filter of slit lamp was used, and the tonometer was moved forward slowly until the prism (0-180) gently touches the center of the cornea. Then the dial of the tonometer was calibrated until the two fluorescein semi-circles appear as horizontal 'S' shape

The measurements of IOP were performed at baseline (before caffeine intake), then the subject asked to drink a cup of coffee (made from Kazar capsules from Nespresso) that contains 240mg of caffeine dissolved in 80 ml of water. Sixty minutes later, the second IOP measurement was taken. The subject asked to not eat or drink any other sources of caffeine in the period between the measurements.

Statistical Analysis

The data were collected using the Microsoft Excel program (Microsoft Office 2013, Microsoft Corp., Redmond, WA, USA). The data were analyzed using SPSS software (version 22; IBM, Armonk,

NY, USA). It was presented as Mean ± SD. Descriptive statistics were used for basic demographic data. All data were normally distributed. Paired t-test was used to calculate the difference between IOP measurements. P-value <0.05 considered as a significant value. The IOP test was performed for both eyes, and there were no significant differences in measurements between the two eyes, by using the paired sample t-test, P<0.05). The data of both eyes were highly correlated and, therefore, the measurements from the right eye were used [20]. Sample size calculations were conducted using http://statulator.com/SampleSize/ss2PM.html. by using mean difference and standard deviation of the differences from previous study done in 2019 http://www.journaljammr.com/index.php/JAMMR/article/view/30117. This study would require a sample size of 1 to achieve a power of 80% and a level of significance of 5%, for detecting a mean of the differences of 2.4 between pairs, assuming the standard deviation of the differences to be 0.8.

Results

Sixty healthy Saudi subjects participated in this prospective cross-sectional study, 45 were females (75%) and 15 were males (15%). Their ages range from 18 to 27years (mean ± SD= 21.52 ± 2.08 years). The mean± SD of the refractive error (spherical equivalent) was -0.57 ±0.68 SD. Table 1 shows the demographic data. Table 2 shows the mean ± SD, mean difference and p-value of the IOP measurements at baseline and after 60 minutes of coffee drinking for total subjects, male and female. The results of Paired t-test show that there is statically significant difference in IOP measurements in total subjects, male and female (P<0.0001). When all subjects considered, the mean IOP measurements at baseline was 13.68 mmHg ± 1.61 and it increased after 60 minutes to 15.46 mmHg ±1.87. The paired t-test shows that there is statically significant difference, the mean difference was (1.79 mmHg, p-value < 0.0001), (Figure 1).

Table 1: Demographic data of subjects.

	Mean ± SD of age	Mean ± SD of refractive error (spherical equivalent)
Total subjects (n=60), Age range (18-27)	21.52 ± 2.08 years	-0.57 ± 0.68 SD
Male (n=15), Age range (18-27)	21.66± 2.25 years	-0.96± 0.79 SD
Female (n=45), Age range (18-27)	21.39± 1.84 years	-0.97± 1.08 SD

Table 2: Means ± standard deviation, mean difference and p-value of the IOP measurements at baseline and after 60 minutes of coffee drinking in total subjects, male and female.

	Mean ± SD of IOP at baseline	Mean ± SD of IOP after 60 minutes	Mean difference	P-value
Total subjects (n=60)	13.68 mmHg ± 1.61	15.46 mmHg ±1.87	1.79 mmHg	p-value< 0.0001
Male (n=15)	14.40 mmHg± 1.43	16.21 mmHg ±1.67	1.81 mmHg	p-value < 0.0001
Female (n=45)	13.47 mmHg ± 1.43	15.26 mmHg ±1.47	1.78 mmHg	p-value < 0.0001

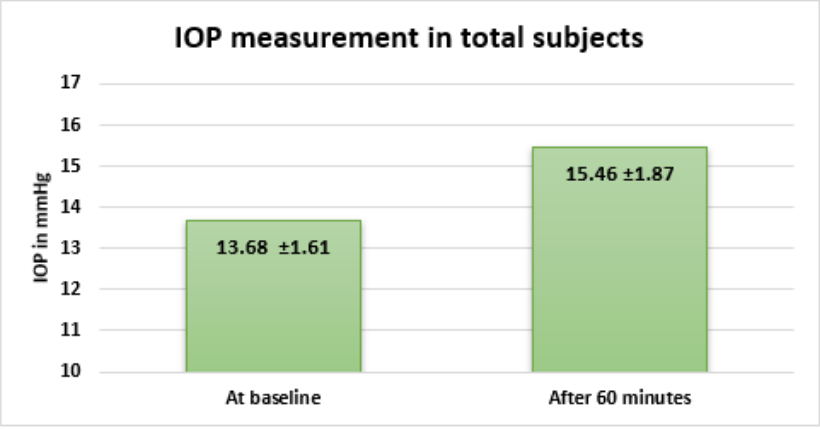

Figure 1: Histogram shows the mean ±SD IOP at baseline and after 60 minutes of coffee drinking in all subjects. The mean difference was (1.79mmHg, P-value < 0.0001).

In male subjects, the mean IOP measurements at baseline was 14.40 mmHg± 1.43 and it increased after 60 minutes to 16.21 mmHg ±1.67. The paired t-test shows that there is statically significant difference, the mean difference was (1.81mmHg, p-value < 0.0001), (Figure 2).

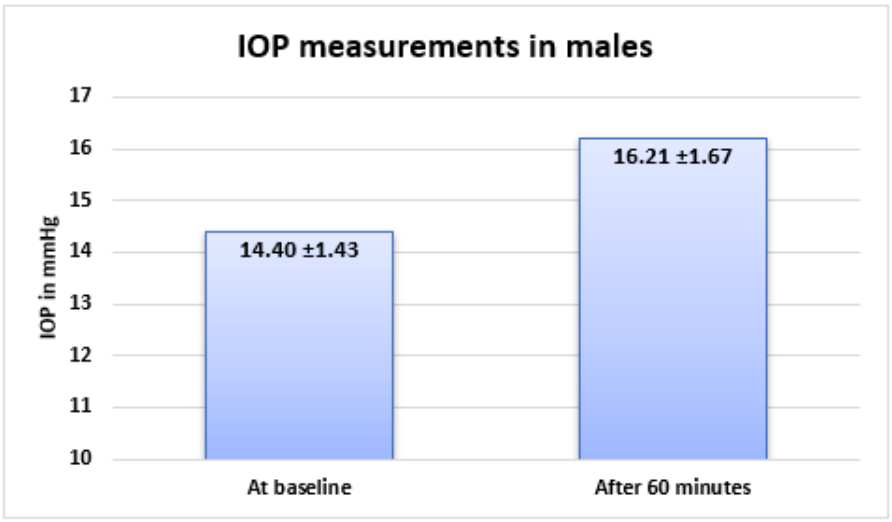

Figure 2: Histogram shows the mean ±SD IOP at baseline and after 60 minutes of coffee drinking in male subjects. The mean difference was (1.81mmHg, P-value < 0.0001).

While in the female subjects, the mean IOP measurements at baseline was 13.47mmHg ± 1.43 and increased after 60 minutes to 15.26mmHg ±1.47. The paired t-test shows that there is statically significant difference, the mean difference was (1.78mmHg, p-value < 0.0001), Figure 3. It is unclear whether the IOP changes observed in our study are clinically significant.

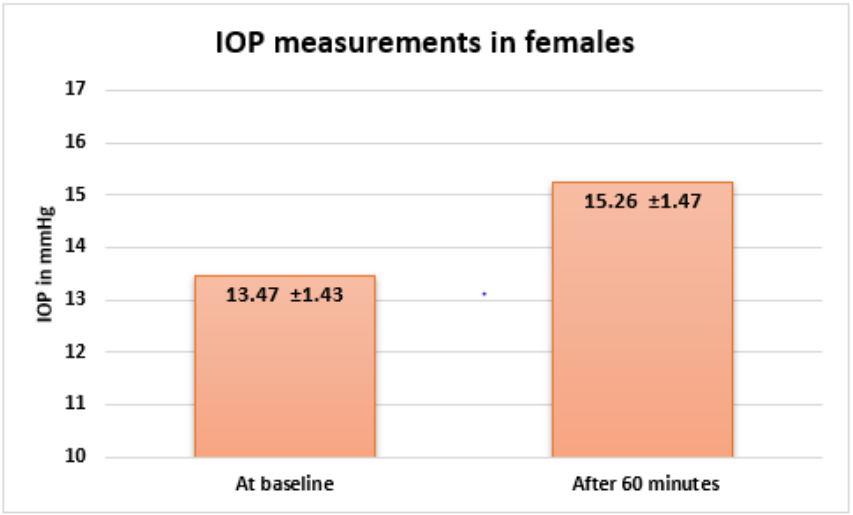

Figure 3: Histogram shows the mean ±SD IOP at baseline and after 60 minutes of coffee drinking in female subjects. The mean difference was (1.78mmHg, P-value < 0.0001).

Discussion

Caffeine has been reported to significantly increase IOP blood pressure 30, 60 and 90 minutes after ingestion. This finding has been confirmed in healthy subjects [21] and systemic hypertensive patients [22]. In this prospective cross-sectional study, by using the gold standard tonometry (Goldmann applanation tonometry) we demonstrated that an increase of IOP would result after 60 minutes of consuming a cup of coffee that contains 240 mg of caffeine and dissolved in 80 ml of water. The mean difference in total subjects was 1.79 mmHg, in male was 1.81 mmHg and in female was 1.78

mmHg. The results were statistically significant p-value <0.000. However, it is unclear whether the IOP changes observed in our study are clinically significant. Our findings are similar to the finding from previous studies [5,6], although the mean differences are not identical, the results were statistically significant. These tiny differences could be due to the different caffeine dose, age group, and instruments used in previous studies. Nwosu, et al [5] examined the effect of graded doses of caffeine on IOP in a healthy Nigerian population. One hundred subjects comprising 46 males and 54 females aged 20 – 76 years old were recruited. Subjects were divided into 4 groups (25 subjects in each group), 3 groups drank a cup of coffee, and the dose of caffeine differs in each group. The 4th group drank 600ml of water and considered a control group. The amount of caffeine in the first group was 0.7 mg/kg, 2.1 mg/kg in the second group, and 3.5 mg/kg of the bodyweight of Nescafé classic coffee in 600 ml of war in the third group. The mean differences of IOP after 60 minutes of coffee drinking were 2.32mmHg in the 1st group (p=0.027), 4.72mmHg in the 2nd group (p=0.001), 5.20mmHg in the 3rd group (p=0.001). The mean difference in the 4th group who drank a cup of water was 0.32mmHg and (p=0.77). The mean differences of this study are higher than ours, this could be because the caffeine dose was related to the weight of the subject. Also, the difference in the age group, the number of males and females might affect the results. Moreover, Jiwani, et al. [6] examined the effect of caffeinated coffee on IOP by using Pascal Dynamic Contour Tonometer. Twenty-five healthy subjects aged between 40-89 years old participated in this clinical trial, it was a prospective, randomized, double-masked crossover study. Out of 25 subjects, 11 were males and 14 were females. Each subject drank a cup of coffee that contains 182 mg of caffeine and dissolved in 237 ml of water. After 60 minutes, the mean difference was 1.51 mmHg, and (p=0.0001). The mean difference in our study was higher, this could be due to the caffeine dose was higher in our study, different in age group, race, the instrument used to measure IOP and sample size. Moreover, in this study we used gold standard tonometry, Goldmann applanation tonometry, it is an accurate device to measure the IOP than the other instruments. Our study is limited by some conditions, the sample size was small, and the number of females was higher than the number of males. Also, the age range supposed to be wide.

Conclusion

This is the first study assessing IOP after caffeinated coffee consumption among Saudi population using the gold standard tonometer (Goldmann applanation tonometry). We found that caffeine has a significant effect on IOP. The IOP increased significantly after drinking a cup of coffee in normal subjects, it is very vital and calls for more public awareness. Thus, we recommend further research to study the effect of caffeine on ocular hypertension patients and glaucoma patients. In addition to that, we recommend further research to study the effect of caffeine in a wider age range, and different coffee types such as Arabic coffee since it is the most popular drink among Saudi population.

Acknowledgements

None.

Conflicts of Interest

None.

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