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Abstract

Purpose: To determine the structural changes of the anterior chamber angle (ACA) and anterior chamber depth (ACD) associated with caffeine consumption among young Saudi healthy subjects by using Pentacam.

Method: A total of 35 female healthy Saudis participated in this prospective cross-sectional study. Subjects were aged between 18 and 30 years, they were recruited from King Saud University (KSU Girls Campus), Riyadh, in optometry department clinics. All subjects had normal ocular surface, spherical equivalent $< \pm 4.00$ DS, free from systemic diseases. Subjects fasted from caffeine for at least 24 hours and discontinued wearing contact lenses for three days before the test. Measurements of ACA and ACD were taken for at least four hours from waking up. Pentacam was used to measure the ACA and ACD, then the subjects drank a cup of coffee that contains 240 mg of caffeine and 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 mean age of participants was 20.9 ± 42.04 . The results showed that a single cup of coffee that contains 240 mg of caffeine not significantly change the parameters of ACA and ACD after 60 minutes. The mean of ACA at baseline measurement was $38.43^{\circ} \pm 5.09$ and increased after 60 minutes to $38.47^{\circ} \pm 4.85$ with a mean difference of (0.04° and P-value = 0.903). The mean of ACD at baseline measurement was $3.02 \text{ mm} \pm 0.29$ and decreased after 60 minutes to $2.98 \text{ mm} \pm 0.30$ with a mean difference of (0.03 mm and P-value = 0.141).

Conclusion: The results of this study showed no significant differences in increasing ACA and reduction of ACD in healthy subjects after drinking an acute dose of caffeine (240 mg/80 ml of water). We recommend further research to study the effect of caffeine on large sample size and on subjects at high risk for glaucoma onset or progression.

Keywords: Caffeine; ACD; ACA; Pentacam; Healthy Saudi Subjects

Introduction

Caffeine is a naturally present chemical stimulant that is called trimethylxanthine. It is a bitter alkaloid and its chemical formula is $C_8H_{10}N_4O_2$ [1]. Because its hydrophobic characteristic it passes all biological membranes and, after oral intake it will distribute to all organs including the central nervous system and the eyes [2]. Caffeine generally found in tea, coffee and cacao plants. Most people in the world (about 80%) consumed caffeinated tea and coffee daily [3].

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Caffeine influences the nervous system by binding and inhibiting adenosine receptors [4]. 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 [5]. 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 [6-12].

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 [13]. Maintaining the IOP within the normal range (10 - 21 mmHg) is necessary for the health of the eye. The effects of caffeine on IOP [14], pupillary response [15], choroidal thickness [16], and macular degeneration [17] have been widely evaluated in previous studies. However, until recently, there are very limited data about the effect of caffeine intake on anterior chamber angle (ACA) or anterior chamber depth (ACD) [18,19].

The measurement of the ACD and ACA is obtained by the use of tomography. There are many devices provide the anterior segment tomography like anterior segment optical coherence tomography (AS-OCT), ultrasound biomicroscopy (UBM), Artemis and Pentacam. In this study we used the Pentacam (OCULUS HR), it is a high-resolution rotating Scheimpflug camera system for anterior segment analysis. It is the gold standard in anterior eye segment tomography. The rotational measuring procedure generates Scheimpflug images in 3D, with the dot matrix fine-meshed in the center due to the rotation. It takes 2 seconds to generate a complete image of the anterior eye segment. It provides us with a 3D image of the anterior segment including various parameters like central corneal thickness (CCT), corneal topographic parameters, ACD, ACA, and anterior chamber volume (ACV). Pentacam has several advantages it is used widely in most of ophthalmology clinics because it has good reliability, works automatically and considered a non-contact device [20].

There are several factors affect ACD and ACA including age [21], sex [22], ethnicity [23], refractive error [24] and caffeine [18,19]. From our review of literature, we found a study conducted by Sun., *et al.* [21] in (2012) to evaluate the effect of age on various anterior segment parameters in healthy eyes. A total of 388 consecutive Korean subjects aged 30 to 89 years was imaged by AS-OCT. They found that ACA gradually narrows with age. Another study done by Yamashita., *et al.* [22] in (2012) to investigate the sex-related differences and the association in ACD. The study included 98 right eyes of healthy young Japanese, 69 eyes from men and 29 eyes from women. The study revealed that the ACD was significantly shallow in women. Moreover, Wang., *et al.* [23] in (2012) examined the ACA and their relationship with the drainage angle between adult Caucasians and Chinese. Data from 121, 124, 121, and 120 participants were obtained of American Caucasians, American Chinese, and Southern and Northern mainland Chinese, respectively. The results of the study showed that ethnic Chinese had smaller ACA independent of ACD.

However, we found a very few studies that designed to determine the effect of caffeine on ACA and ACD. A recent study done by Redondo., *et al.* [18] in (2020) assessed the structural changes in cornea and anterior chamber that associated with caffeine ingestion. Seventeen healthy subjects aged 27.4 ± 6.6 years ingested a capsule of low caffeine (~ 4 mg/kg) or placebo (300 mg of cornstarch) in a counterbalanced manner. The authors measured IOP by rebound tonometry and the Pentacam rotating Scheimpflug camera for ACA, ACD and CCT. All the dependent variables were obtained at baseline, 30, 60 and 90 min after caffeine/placebo intake. The results showed that caffeine intake caused an acute IOP rise and a narrowing ACA. However, there was no effect on ACD and CCT.

The other study done by Uzun., *et al.* [19] in (2019) evaluate the ocular biometric changes in healthy subjects after caffeine consumption from a cup of coffee. A total of 36 subjects aged 30.05 ± 7.43 were included in the study. Anterior segment parameters including ACD and CCT were measured with optic biometry, Lenstar LS 900 (Haag-Streit, Inc., Koeniz, Switzerland) at baseline, 1 and 4h after ingesting a cup of coffee (60 mg caffeine/100 mL). The study revealed that caffeine causes a significant increase ACD following oral intake, for at least 4 h and no statistically significant difference was determined in terms of CCT.

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In fact, we were unable to retrieve a study that reported the effect of caffeine on ACA and ACD among Saudi population. Since coffee is most preferred drink in Saudi Arabia, therefore, we aim in this study to investigate the structural changes of ACA and ACD associated with caffeine consumption among young healthy Saudi subjects by using Pentacam. The importance of this study in clinical implications, it could raise the awareness in designing the caffeine diet in glaucoma patients.

Methods

This is a prospective cross-sectional study conducted in Optometry clinics at king Saud university (KSU Girls Campus), in Riyadh, Saudi Arabia, from December 2020 to March 2021. It was performed in accordance with the tenets of the Declaration of Helsinki [25], regarding research involving human subjects. The study was approved by the ethical committee at King Saud University Medical City (ethics number E-20-5345) and the informed consent was obtained from the participants included in the study.

Thirty-five female healthy young Saudi subjects aged between 18 and 30 years old, without ocular or systemic diseases and have spherical equivalent < ± 4.00DS 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 test. Measurements of ACA and ACD 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 $> \pm 4.00D$. The tests include refraction by AutoRef/Keratometer (NIDEK, ARK-1) and anterior segment eye examination by slit lamp (Topcon).

The ACA and ACD measured by one well trained examiner. The measurement was taken by Pentacam rotating Scheimpflug camera (Oculus HR) at baseline (before caffeine intake), then the subject drunk a cup of coffee (made from Kazar capsules from Nespresso) that contains 240 mg of caffeine dissolved in 80 ml of water. Sixty minutes later, the second measurement of ACA and ACD were taken. All measurements were taken from both eyes. The subject asked to not eat or drink any other sources of caffeine in the period between the measurements.

During test the subject positioned in a chin and forehead rest after disinfection with alcohol and is asked to fixate on a black fixation target. A rotating Scheimpflug camera rotates 360° around the optical axis, and when a scan is completed, the Pentacam software calculates the anterior ACA and ACD.

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 \pm SD. Descriptive statistics were used for basic demographic data. All data were normally distributed. Paired t-test was used to calculate the difference between measurements at baseline and 60 min later. P-value < 0.05 considered as a significant value. The ACA and ACD test were 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 in statistical analysis [26].

Sample size calculations were conducted through website http://statulator.com/SampleSize/ss2PM.html. By using mean difference and standard deviation of the ACA from previous study published in 2020 https://pubmed.ncbi.nlm.nih.gov/31823063/. This study would require a sample size of 5 to achieve a power of 80% and a level of significance of 5%, for detecting a mean of the differences of 2.35 between pairs, assuming the standard deviation of the differences to be 0.94.

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Results

Thirty-five female healthy Saudi subjects participated in this prospective cross-sectional study. Their ages range from 18 to 30 years (mean \pm SD = 20.94 \pm 2.04 years). The mean \pm SD of the refractive error (spherical equivalent) was -0.57 \pm 0.68 DS.

The mean ± standard deviation, mean difference, and P-value of ACA and ACD measurements at baseline and 60 minutes of coffee drinking are shown in table 1.

Measurements	At baseline	After 60 minutes	Mean difference	P-value
ACA	38.43° ± 5.09	38.47° ± 4.85	0.04°	0.903
ACD	3.02 mm ± 0.29	2.98 mm ± 0.30	0.03 mm	0.141

Table 1: The mean ± standard deviation, mean difference, and P-value of ACA and ACD measurements at baseline and 60 minutes of coffee

 drinking.

ACA: Anterior Chamber Angle; ACD: Anterior Chamber Depth.

From table 1, the results of paired t-test show that there is no statically significant difference in ACA and ACD measurements. The mean of ACA at baseline was $38.43^{\circ} \pm 5.09$ and increased after 60 minutes to $38.47^{\circ} \pm 4.85$ with a mean difference of (0.04° and P-value 0.903). The mean of ACD at baseline was $3.02 \text{ mm} \pm 0.29$ and decrease after 60 minutes to $2.98 \text{ mm} \pm 0.30$ with a mean difference of (0.03 mm and P-value 0.141).

Discussion

It is controversial that intake of caffeine has an impact on IOP. Caffeine has been reported to significantly elevate IOP at 30, 60 and 90 minutes after ingestion. This finding has been confirmed in healthy subjects [27] and systemic hypertensive patients [28]. Some researchers demonstrated that coffee consumption has no effect on IOP in the healthy population unlike results in an elevation of IOP in patients with glaucoma [9].

Previous studies have suggested that the main cause of the IOP rise after caffeine intake is the promoted production of aqueous humour, possibly explained by an increased blood pressure [27,29,30]. It is important to assess how the structures of the anterior chamber and angle affect IOP. Shallow ACD was reported as a strong risk factor for angle closure glaucoma [31,32]. However, until recently, there are very limited data about the effect of caffeine intake on ACA or ACD [18,19].

In this prospective cross-sectional study, by using the standard technique of anterior chamber measurements (Pentacam) we demonstrated that an increase of ACA and decrease of ACD would result after 60 minutes of consuming a cup of coffee that contains 240 mg of caffeine and dissolved in 80 ml of water in healthy subjects. The mean difference of ACA and ACD from the value at baseline was 0.04° and 0.03mm respectively but both parameters showed no significant differences P-value 0.903 and P-value 0.141 respectively.

The results of our study disagreed with previous studies [18,19]. For example, the study done by Redondo., *et al.* in (2020) showed that caffeine intake caused an acute IOP rise and a narrowing ACA 39.53 \pm 5.46, 37.18 \pm 4.52 at baseline and after 60 minutes respectively. The mean difference was 2.5°, and was statically significant P = 0.028. However, there was no effect on CCT and ACD, P = 0.798, P = 0.346 respectively [18].

In addition to that, Uzun., et al. in (2019) evaluated the ocular biometric changes in healthy subjects after caffeine consumption from a cup of coffee. Anterior segment parameters including ACD, and CCT were measured with optic biometry Lenstar LS 900 (Haag-Streit)

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at baseline, 1 and 4 hours after ingesting a cup of coffee (60 mg caffeine/100 mL). The study revealed that caffeine causes a significant increase ACD following oral intake at 60 minutes. At baseline the ACD was 3.60 ± 0.32 mm and at 1 hour increase to 3.66 ± 0.31 mm, mean difference 0.06 mm with statically significant P-value 0.005 [19].

The results of our study conflicted with previous studies, this may due to the different of caffeine dose, age range, sample size, race, gender, refractive error, different instruments used and the difference in caffeine consumers.

Our study is limited by some conditions, the sample size is small, all subjects were females due to limitation of accessing the male to the clinic because of COVID 19. Also, the age group is not wide. Moreover, we have not determined the full duration of the changes in the parameters observed in our trial.

Conclusion

The results of this study showed no significant differences in increasing ACA and reduction of ACD in healthy subjects after drinking an acute dose of caffeine (240 mg/80 ml of water). We recommend further research to study the effect of caffeine on large sample size and on subjects at high risk for glaucoma onset or progression.

Authors' Contributions

Study conception and design: Wafa Majed Alotaibi.

Acquisition of data: Noor Saleh Almuzaini.

Analysis and interpretation of data: Wafa Majed Alotaibi, Noor Saleh Almuzaini.

Drafting of manuscript: Wafa Majed Alotaibi.

Critical revision: Wafa Majed Alotaibi.

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Ethics Approval and Consent to Participate

The study was approved by the ethical committee at King Saud University Medical City. Informed consent was obtained from the participants included in the study.

Conflicts of Interest

We have no conflicts of interest to disclose.

Bibliography

- 1. Caballero B., et al. "Encyclopedia of food and health". Academic Press (2015).
- 2. Kronschläger M., et al. "Pharmacokinetics for topically applied caffeine in the rat". Experimental Eye Research 122 (2014): 94-101.
- 3. Heckman MA., *et al.* "Caffeine (1, 3, 7-trimethylxanthine) in foods: a comprehensive review on consumption, functionality, safety, and regulatory matters". *Journal of Food Science* 75.3 (2010): R77-R87.

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- 4. Nehlig A., *et al.* "Caffeine and the central nervous system: mechanisms of action, biochemical, metabolic and psychostimulant effects". *Brain Research. Brain Research Reviews* 17.2 (1992): 139-170.
- 5. Corti R., *et al.* "Coffee acutely increases sympathetic nerve activity and blood pressure independently of caffeine content: role of habitual versus nonhabitual drinking". *Circulation* 106.23 (2002): 2935-2940.
- 6. Nwosu F EC. "The effect of graded doses of caffeine on intraocular pressure in Niger Delta, Nigeria". *Journal of Advances in Medicine and Medical Research* 29.9 (2019): 1-6.
- 7. Jiwani AZ., *et al.* "Effects of caffeinated coffee consumption on intraocular pressure, ocular perfusion pressure, and ocular pulse amplitude: a randomized controlled trial". *Eye (London, England)* 26.8 (2012): 1122-1130.
- 8. Wu CM., *et al.* "Frequency of a diagnosis of glaucoma in individuals who consume coffee, tea and/or soft drinks". *British Journal of Ophthalmology* 102.8 (2018): 1127-1133.
- 9. Li M., *et al.* "The effect of caffeine on intraocular pressure: a systematic review and meta-analysis". *Graefe's Archive for Clinical and Experimental Ophthalmology* 249.3 (2011): 435-442.
- 10. Chandrasekaran S., *et al.* "Effects of caffeine on intraocular pressure: the Blue Mountains Eye Study". *Journal of Glaucoma* 14.6 (2005): 504-507.
- 11. Avisar R., et al. "Effect of coffee consumption on intraocular pressure". The Annals of Pharmacotherapy 36.6 (2002): 992-995.
- 12. Higginbotham EJ., et al. "The effect of caffeine on intraocular pressure in glaucoma patents". Ophthalmology 96.5 (1989): 624-626.
- Kingman S. "Glaucoma is second leading cause of blindness globally". Bulletin of the World Health Organization 82.11 (2004): 887-888.
- 14. Avisar R., et al. "Effect of coffee consumption on intraocular pressure". Annals of Pharmacotherapy 36.6 (2002): 992-995.
- 15. Bardak H., *et al.* "Effect of single administration of coffee on pupil size and ocular wavefront aberration measurements in healthy subjects". *BioMed Research International* (2016): 9578308.
- 16. Vural AD., *et al.* "Choroidal thickness changes after a single administration of coffee in healthy subjects". *Retina* 34.6 (2014): 1223-1228.
- 17. Tomany SC., *et al.* "The relation of coffee and caffeine to the 5-year incidence of early age-related maculopathy: the Beaver Dam Eye Study". *American Journal of Ophthalmology* 132.2 (2001): 271-273.
- 18. Redondo B., *et al.* "Short-term effects of caffeine intake on anterior chamber angle and intraocular pressure in low caffeine consumers". *Graefe's Archive for Clinical and Experimental Ophthalmology* 258.3 (2020): 613-619.
- 19. Uzun F., *et al.* "The acute effects of single cup of coffee on ocular biometric parameters in healthy subjects". *Journal of Current Ophthalmology* 31.4 (2019): 394-398.
- 20. Colm McAlinden., *et al.* "A comprehensive evaluation of the precision (repeatability and reproducibility) of the oculus pentacam HR". *Investigative Ophthalmology and Visual Science* 52.10 (2011): 7731-7737.
- 21. Sun JH., *et al.* "Factors associated with anterior chamber narrowing with age: an optical coherence tomography study". *Investigative Ophthalmology and Visual Science* 53.6 (2012): 2607-2610.
- 22. Yamashita T., *et al.* "Sex-related differences in axial length, anterior chamber depth and lens thickness in japanese young healthy eyes". *Investigative Ophthalmology and Visual Science* 53.14 (2012): 3626.

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- 23. Wang D., *et al.* "Ethnic difference of the anterior chamber area and volume and its association with angle width". *Investigative Ophthalmology and Visual Science* 53.6 (2012): 3139-3144.
- 24. Xu L., *et al.* "Anterior chamber depth and chamber angle and their associations with ocular and general parameters: the Beijing Eye Study". *American Journal of Ophthalmology* 145.5 (2008): 929-936.e921.
- 25. World Medical Association. "World Medical Association Declaration of Helsinki. Ethical principles for medical research involving human subjects". *Journal of the American Medical Association* 310.20 (2013): 2191-2194.
- 26. McAlinden C., *et al.* "Statistical methods for conducting agreement (comparison of clinical tests) and precision (repeat-ability or reproducibility) studies in optometry and ophthalmology". *Ophthalmic and Physiological Optics* 31.4 (2010): 330-338.
- 27. Ajayi OB and Ukwade MT. "Caffeine and intraocular pressure in a Nigerian population". *Journal of Glaucoma* 10.1 (2001): 25-31.
- 28. Hartley TR., et al. "Hypertension risk status and effect of caffeine on blood pressure". Hypertension 36.1 (2000): 137-141.
- 29. Kurata K., *et al.* "Aqueous humor dynamics in beagle dogs with caffeine-induced ocular hypertension". *Journal of Veterinary Medical Science* 60.6 (1998): 737-739.
- 30. Kurata K., *et al.* "Relationship between caffeine induced ocular hypertension and ultrastructure changes of non pigmented ciliary epithelial cells in rats". *Journal of Toxicological Sciences* 22.5 (1997): 447-454.
- 31. Lavanya R., et al. "Determinants of angle closure in older Singaporeans". Archives of Ophthalmology 126.5 (2008): 686-691.
- 32. Tamelik NAE., *et al.* "Medical and surgical treatment of primary angle closure glaucoma". *Turkish Journal of Ophthalmology* 42.1 (2012): 1-7.

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