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Original Research

Changes in Choroidal Thickness Following Energy Drink Consumption in Healthy Subjects

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ABSTRACT

Objective: This study aims to investigate the effects of consumption of energy drink (ED) on subfoveal choroidal thickness (CT) using enhanced depth imaging spectral domain optical coherence tomography (EDI-OCT).

Methods: In this study, 40 healthy volunteers who consumed 250 mL ED and 40 healthy subjects who consumed 250 mL water were enrolled. All volunteers underwent EDI-OCT scanning for subfoveal CT measurement at baseline and following time periods after ED or spring water consumption. The OCT scannings were performed by the same physician, and all subfoveal CT measurements were manually taken by two independent masked physicians. All subfoveal CT measurements for both groups were analyzed by repeated measure analysis.

Results: Our results showed no significant difference in baseline and following subfoveal CT measurements between the groups ($p>0.05$, for all). The difference in mean values among the following seven measurement periods was not statistically significant in the study and control groups ($p=0.417$ and $p=0.856$, respectively).

Conclusion: The ED in our study did not significantly change subfoveal CT in spite of the caffein content. This may be because of the interactions of caffein with other ingredients of the ED.

Keywords: Energy drinks, choroid, optical coherence tomography

INTRODUCTION

Energy drinks (EDs) are popular among young people worldwide (1, 2). Main consumers are students and athletes in the second and third decades of age (3). The most common ingredients of EDs are caffeine, taurine, various vitamins, glucose, and herbal extracts (4). Caffeine is the stimulatory effective ingredient of EDs (5). However, researchers observed a synergistic effect among the ED ingredients. They also showed that the EDs improved performance more than that by the caffeine content alone (6, 7).

Caffeine is the most commonly consumed psychoactive alkoloid in the world (8). It reaches maximum plasma concentration between 20 and 120 min with a half-life of 3-6 h. Blood pressure changes develop in 30 min, peak in 1-2 h, and may persist for over 4 h (9). Caffeine may significantly reduce macular circulation and choroidal thickness (CT) (10-12). It may also cause transient increase in intraocular pressure and changes in retrobulbar blood flow (13-15).

We aimed to assess the effects of ED consumption on subfoveal CT using enhanced depth imaging spectral domain optical coherence tomography (EDI-OCT) in healthy subjects. To best of our knowledge, this study is the first report that specifically assessed the effect of ED consumption on subfoveal CT.

METHODS

In this prospective observational study, 40 eyes of 40 healthy participants for study group and 40 eyes of 40 healthy participants for control group were included. All participants gave informed consent, and approval of the ethics committee was received from the Gaziantep University. The study followed the principles of the Declaration of Helsinki.

Participants

The participants underwent complete ophthalmic examination. Those who had best-corrected visual acuity of at least 20/20 without any ocular pathology were included in this study. Participants who had intraocular pressure readings >20 mmHg, metabolic diseases, systemic diseases, smokers, pregnants, drug usage, and alcohol abuse were excluded from the study. Additionally, participants who consumed any beverage with caffein or chocolate in the last 24 h were excluded. They were randomly assigned to study or control groups. The participants in study group received a 250 mL can of ED (including 150 mg/l caffeine, 200 mg taurine, B-group vitamins, glucose, sucrose, and water), and those in control group received 250 mL spring water. Only right eye of each participant was examined. The axial length, spherical equivalent, weight, height, and body mass index (BMI) values of each participant were noted. The measurements were

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Table 1. Demographic and clinical characteristics of study and control groups

	Study Group	Control Group	p*
Number			
Eyes/Patients	40/40	40/40	–
Sex			
F/M	20/20	20/20	–
Age, years			
Mean±SD	26.6±4.8	25.2±3.4	0.108
Range	(19–40)	(19–39)	
SE			
Mean±SD	–0.90±1.4	–1.13±1.5	0.478
Range	(–4.00–+4.00)	(–4.00–+3.75)	
AL, mm			
Mean±SD	2420±0.74	24.17±0.90	0.901
Range	(22.83–25.85)	(22.17–25.99)	
Weight, kg			
Mean±SD	71.1±13.9	71.3±15.2	
Range	(50–100)	(51–113)	0.951
Height, cm			
Mean±SD	171.2±8.9	172.3±8.4	0.580
Range	(158–190)	(157–191)	
BMI, kg/m^2			
Mean±SD	24.1±3.6	23.8±3.2	0.695
Range	(18.6–32.6)	(18.3–32.5)	

* Independent student's t–test
F: female; M: male; SD: standart deviation; SE: spherical equivalent; AL: axial length; BMI: body mass index

performed between 9:00 am and 03:00 pm to eliminate any possible diurnal choroidal variation. Measurements were performed at 5 and 30 min as well as at 1, 2, 3, 4, and 6 h following ED or spring water consumption.

Subfoveal CT Measurement

The OCT scans were performed by an experienced clinician using Heidelberg® Spectralis® SD-OCT (Heidelberg Engineering, version:1.8.6.0, Heidelberg, Germany) with EDI modality. A line scan of 30° consisting of 768 A-scans per frame was used. This image was averaged for 100 scans using the automatic averaging and eye-tracking features (16). The subfoveal CT was defined as the vertical distance from the outer surface of the retinal pigment epithelium to the inner surface of the sclera at the fovea. Subfoveal CT values were measured independently by two masked ophthalmologists (S.A.Y and I.E.Y). Measurement differences of >10% between the interpreters were excluded from the study.

Table 2. The mean subfoveal CT measurements of participants at baseline, 5 min, 30 min, 1, 2, 3, 4, and 6 h

	Study Group (Mean±SD)	Control Group (Mean±SD)	p*
Baseline	350.7±72.2	367.7±55.4	0.240
5 min	352.1±72.1	367.9±56.6	0.278
30 min	352.7±72.2	368.4±55.2	0.280
1 h	351.0±72.2	368.6±55.5	0.226
2 h	351.6±72.3	369.7±54.8	0.210
3 h	351.4±71.7	368.9±54.6	0.223
4 h	349.7±70.1	368.6±53.9	0.180
6 h	350.5±71.7	368.2±53.5	0.214

All measurements are in mm
*Independent student's t–test; SD: standart deviation

Statistical Analysis

We used Statistical Package for the Social Sciences 16.0 (SPSS Inc.; Chicago, IL, USA) to analyze outcomes. Kolmogorov-Smirnov test was used to check normality for each continuous variable. Independent student's t-test was used to analyze the categorical variables and subfoveal CT values between the groups. Subfoveal CT values for both groups were analyzed by repeated measure analysis. A p value of <0.05 was considered to be statistically significant.

RESULTS

We enrolled 40 eyes of 40 participants in the study group, and 40 eyes of 40 participants in the control group. Clinical and demographic properties are shown in Table 1. Age, spherical equivalent, axial length, weight, height, and BMI did not significantly differ between the groups (p>0.05 for all).

The mean subfoveal CT measurements of participants at baseline and following periods are shown in Table 2. No statistically significant difference between the groups in mean subfoveal CT measurements at baseline and following periods (p>0.05 for all) was observed.

The difference in mean subfoveal CT among the following six measurement periods was not statistically significant in the study and control groups (p=0.417, F=0.417; p=0.856, F=0.470; respectively).

DISCUSSION

The consumption of EDs, especially in young adults and athletes, has become a worldwide phenomenon. The EDs are frequently consumed to increase performance, counteract sleepiness, and maintain alertness (1). They contain stimulants like caffeine, taurine, herbal extracts, and B-vitamins. The amount of caffeine in

EDs per can varies between 75 and 150 mg (17). Adenosine has a potent vasodilatory effect on multiple vascular beds. Researchers showed that in animal studies, adenosine causes an increase in cerebral blood flow and retinal vessel diameter (18). The exact mechanism of caffeine is still debated, but it is believed that caffeine inhibits vasodilation by competing with adenosine for its receptor (19). Kerrison et al. (20) reported five heavy caffeine consumers who developed central ring scotomas without visual loss. They explained the responsible pathophysiological mechanism by vasoconstriction and transient ischemia of macula. Lotfi and Grunwald reported 200 mg of caffeine reduced retinal blood flow by approximately 13% using blue field stimulation technique (10). Okuno et al. (11) measured choroid-retina blood flow using laser speckle tissue analyzer and showed that blood flow decreased by 6% in the first hour after an oral administration of 100 mg caffeine. They thought that caffeine might reduce blood flow in the optic nerve head and choroid by increasing vessel resistance. Ozkan et al. (13) reported that caffeine (300 mg) affects retrobulbar blood flow by increasing the resistive index of the ophthalmic, central retinal, and nasal posterior ciliary arteries. Vural et al. (12) reported that drinking 100 mL Turkish coffee (57 mg caffeine) causes a significant reduction in subfoveal CT for at least 4 h (12). In a recent study, Zengin et al. (21) reported similar results. Contrary to previous reports, we observed no statistically significant change in subfoveal CT in the study group. Other synergistic vasoactive and non-vasoactive agents in ED somewhat limit the temporary vasoconstrictive effect of caffeine on choroidal vessels. We showed only the short-term effect of a single-type ED's ingredients combination on CT. The ingredients were not individually evaluated. Therefore, it is impossible to specify whether the effects were the result of an interaction among ingredients. The combination of caffeine and taurine in EDs has been known to have synergic effect on cognitive performance (22). Cardiovascular effects of taurine are similar to those of caffeine (23). To the best our knowledge, acute effects of isolated taurine or caffeine-taurine combination on choroid is unknown.

Despite advances in imaging technology, adequate imaging of the choroid is still lacking. Other imaging techniques, such as B-scan ultrasonography and ICG, are limited in image resolution and measurement accuracy. The EDI-OCT provides evaluation of the choroid, and facilitates understanding of the chorioretinal abnormalities and diseases (24). Osmanbasoglu et al. showed that the mean diurnal variation of central CT was not significiant between 9:00 am and 4:00 pm (25). In our study, we performed all measurements between 9:00 am and 3:00 pm. We did not observe any significiant variation among the measurement times in participants.

Our study has some limitations. Firstly, the concentration of caffeine and other ingredients vary among different EDs. In the US market alone, >300 different EDs are available (17). The fact that this study only compared a single-type ED (150 mg/l caffeine, 200 mg taurine, B-group vitamins, glucose, sucrose, and water) with spring water as a control provides limited information on the relative contribution of these ingredients. Thus, these results cannot be generalized to other EDs. Secondly, the CT was not directly measured in this study.

CONCLUSION

The ED we used in our study did not change subfoveal CT despite the fact that it had caffein as a main ingredient. The effect of caffein on the CT may be limited by the interactions with other ingredients of the ED. To the best our knowledge, this is the first report evaluating the acute effect of EDs on subfoveal CT using EDI-OCT. Further studies are required to investigate the effects of EDs on CT.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Gaziantep University.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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