Impact of Caffeine Intake on Ocular Physiology

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Abstract

Background: Caffeine is the most widely consumed psychoactive substance, exhibiting dose-dependent pharmacological effects on biological tissues. **Objective:** To investigate how the systemic effects of caffeine, acting primarily as an adenosine receptor antagonist, translate to measurable changes in ocular physiology, specifically accommodation, pupillary response, and intraocular pressure (IOP). **Methods:** A cross-sectional study was conducted on 88 healthy individuals aged 19–30 years. Participants were divided into Group A (n=44, consuming 50 mL coffee containing 1.2g caffeine) and Group B (n=44, non-consuming control). Accommodation, pupil size, and IOP were measured at baseline, 20 minutes, and 40 minutes post-consumption. **Results:** At 20 minutes post-consumption, Group A demonstrated a statistically significant transient enhancement in accommodation for both eyes (OD: p=0.044, OS: p=0.012) and a highly significant, asymmetric pupil dilation in the right eye (OD: p=0.001). These parameters returned to baseline by 40 minutes. IOP remained clinically unaffected at all time points. **Conclusion:** Caffeine temporarily enhances accommodation and induces brief, asymmetric pupil dilation but does not substantially impact IOP.

Keywords: Caffeine, Accommodation, Pupil, Intra Ocular Pressure, IOP

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1. Introduction

Caffeine is the world's most consumed psychoactive substance, commonly present in coffee, tea, energy drinks, chocolate, and various medications. Its pharmacological effects on biological tissues are diverse and heavily dose-dependent. Systemically, caffeine acts primarily as an adenosine receptor antagonist. This antagonism leads to autonomic nervous system stimulation, alterations in smooth muscle relaxation and contraction, and overall central nervous system arousal.

While the systemic manifestations of caffeine are well-documented, this study investigates how these systemic effects translate into measurable changes in specific ocular parameters. The key parameters of interest include:

- **Accommodation:** The eye's ability to adjust focus across distances by contracting or relaxing the ciliary muscles, thereby altering the shape of the crystalline lens.
- **Pupillary Response:** Regulated by the autonomic nervous system, this dynamic response to light changes controls light entry and heavily influences visual perception.
- **Intraocular Pressure (IOP):** The pressure exerted by aqueous humour, governed by the balance between aqueous humour production and drainage.

2. Objectives

The primary objective of this study is to measure and analyze the impact of acute caffeine intake on three key ocular parameters: amplitude of accommodation, pupil size, and intraocular pressure over a defined time course.

3. Methodology

3.1 Study Design & Population

A cross-sectional study was conducted at Sri Devaraj Urs Medical College (SDUAHER), Kolar. The study population comprised 88 healthy young individuals between the ages of 19 and 30 years. Participants were divided equally into two cohorts: Group A (n=44) served as the intervention group and consumed coffee, while Group B (n=44) served as the non-consuming control group.

3.2 Selection Criteria

- **Inclusion Criteria:** Healthy participants of both sexes aged 19–30 years, possessing a refractive correction spherical equivalent of $\leq \pm 0.50$ D, best spectacle-corrected visual acuity of 6/6 or better, and baseline IOP < 21 mmHg.

- **Exclusion Criteria:** Individuals were excluded if they had a history of ocular surgery, systemic or ocular diseases, accommodative anomalies or pupillary defects, or were regular smokers.

3.3 Study Protocol & Measurements

Institutional ethics committee approval was received, and informed patient consent was obtained from all participants prior to enrollment.

All participants underwent a comprehensive baseline ocular examination, including visual acuity, slit lamp, fundus, and IOP evaluations. Following baseline measurements, participants in Group A consumed 50 mL of coffee (containing 1.2g of caffeine). Ocular measurements were then recorded for both groups at Baseline, 20 minutes, and 40 minutes post-consumption.

The measurement protocols were as follows:

1. **Amplitude of Accommodation:** Measured using a Royal Air Force (RAF) Ruler with spectacles at a 15 mm vertex distance and a movable target at 40 cm.
2. **Pupil Size:** Horizontal diameter was measured in dim light using a ruler in centimeters and converted to millimeters.
3. **Intraocular Pressure:** Measured bilaterally utilizing an automated, non-invasive Non-Contact Tonometer (NCT).

4. Results

4.1 Demographics

The study groups were well-matched, demonstrating comparable demographic profiles which minimized confounding variables. The gender distribution was nearly identical, with Group A comprising 50% males and 50% females, and Group B comprising 48% males and 52% females. No significant demographic differences were found between the groups.

Table 1: Baseline Demographics

	Without Coffee	**With Coffee**
Female	23 (0.52 %)	22 (50 %)
Male	21 (0.48 %)	22 (50 %)
Age	23.52 ± 1.12	23.70 ± 1.19
PD(mm)	62.25 ± 1.33	62.20 ± 1.39

Table 1 : Comparison of Gender, Age & PD in Participants Consuming Coffee and without Coffee

4.2 Time-Course Analysis of Ocular Parameters

Baseline ocular measurements for accommodation, pupil size, and IOP were comparable between both groups.

Accommodation: A significant transient enhancement in accommodation was observed in the coffee-consuming group at the 20-minute mark. This enhancement was statistically significant for both the right eye (OD p=0.044) and the left eye (OS p=0.012). The accommodative amplitude returned to baseline levels by the 40-minute mark (OD p=0.118; OS p=0.661).

Pupil Size: Caffeine consumption induced a transient, asymmetric pupil dilation. At 20 minutes post-consumption, the right eye demonstrated a highly significant increase in pupil size (OD p=0.001). The left eye did not show a statistically significant change at 20 minutes (OS p=0.274). Similar to accommodation, the pupil size in the right eye returned to baseline by 40 minutes (p=0.579).

Intraocular Pressure (IOP): There were no significant changes in IOP at any time point for either eye. Measurements at 20 minutes (OD p=0.090; OS p=0.721) and 40 minutes (OD p=0.122; OS p=0.490) remained clinically unaffected by the caffeine intake.

Table 2: Statistical Significance Overview (p-values vs Baseline)

Ocular Parameters		Baseline		20 min Interval		40 min Interval	
		OD	OS	OD	OS	OD	OS
Amplitude of Accommodation (D)	With Coffee	7.898± 0.539	7.864 ± 0.431	8.02± 0.336	8 ± 0.369	7.96± 0.445	7.886± 0.425
	P value			0.044	0.012	0.118	0.661
	Without Coffee	7.57 ± 0.86	7.54 ± 0.82				
Pupil Size (mm)	With Coffee	5.714±0.502	5.703± 0.433	5.95± 0.38	5.75± 0.389	5.70± 0.471	5.713± 0.404
	P value			0.001	0.274	0.579	0.902
	Without Coffee	5.62 ± 0.25	5.69 ± 0.28				
IOP (mm Hg)	With Coffee	15.3± 1.29	14.66±1.31	15.64±1.11	14.84±3.3	14.9±1.99	14.25± 1.23
	P value			0.090	0.721	0.122	0.49
	Without Coffee	14.86 ± 1.36	13.86 ± 1.85				

Table 2 : Comparison of IOP, pupil size and accommodation in both subjects with and without Coffee consumption

5. Discussion

The mechanism of caffeine's action on ocular parameters observed in this study can be attributed to its role as an adenosine antagonist. This antagonism leads to sympathetic stimulation, resulting in the contraction of the iris dilator muscle and subsequent pupil dilation. Furthermore, caffeine increases the tonicity of the ciliary muscle, which translates clinically into enhanced accommodation. The minimal effect observed on aqueous humor production and drainage explains the clinically insignificant changes in intraocular pressure.

Our findings regarding accommodative enhancement and pupillary dilation are consistent with recent literature. Nijin et al. (2024) reported increased accommodation and pupil diameter following caffeine intake.[1] The mechanism of heightened ciliary muscle tonicity is supported by earlier work from Kirshner & Schmid (1984),[2] and our observation of a 20-minute peak effect aligns well with the enhanced accommodative responses documented by Zhai et al. (1993). [3]

Interestingly, our results contrast with Aparajita et al. (2022), who found no significant ocular parameter changes; this discrepancy may be attributed to differences in caffeine dosage or delivery methods between the study designs.[4] Finally, our finding that caffeine has no significant impact on IOP is highly consistent with the literature, including Jiwani et al. (2012), who also reported no significant baseline IOP differences after caffeine consumption. [5]

5.1 Limitations

While not explicitly categorized in the presentation, inherent limitations based on the study's design include the restricted age range of the study population (healthy individuals aged 19–30 years), which may limit the generalizability of the findings to older populations or those with pre-existing ocular or systemic pathologies.

6. Conclusion & Clinical Implications

This study concludes that caffeine transiently enhances accommodation at 20 minutes post-consumption in both eyes and induces brief, asymmetric pupil dilation (observed significantly only in the right eye). Intraocular pressure remains clinically unaffected by acute caffeine intake at any time point.

Clinical Implications:

1. **For Clinical Practice:** The transient nature of these effects—reaching significance at 20 minutes and resolving by 40 minutes—suggests that moderate caffeine intake is unlikely to have lasting clinical consequences on ocular health.
2. **For Ophthalmic Examinations:** Clinicians should consider advising patients regarding caffeine intake prior to

examinations that require precise accommodation or pupillometry measurements, as recent consumption could temporarily skew these results.

3. **For IOP Assessment:** Because caffeine does not significantly alter IOP, no special precautions or restrictions are necessary for patients undergoing tonometry after routine coffee consumption.

References:

1. Nijin SG, Canara AR et al. Exploring the Impact of Caffeine Intake on Ocular Physiology. IJNRD 2024; 9(1).
2. Kirshner AJ, Schmid R. The effects of caffeine on near point plus acceptance. J Am Optom Assoc 1984; 55(2): 97–102.
3. Zhai H, Goss DA, Hammond RW. The effect of caffeine on the accommodative response/ accommodative stimulus function. Curr Eye Res 1993; 12(6): 489–499.
4. Kar A, Chaurasiya N et al. The effect of coffee consumption on IOP and BP. Int J Appl Res 2022; 8(3): 334–338.
5. Jiwani AZ, Rhee DJ et al. Effects of caffeinated coffee on IOP, ocular perfusion pressure, and ocular pulse amplitude. Eye 2012; 26: 1122–1130.

Declarations:

- **Financial Support & Sponsorship:** Nil
- **Conflicts of Interest:** None declared
- **Ethics Approval:** SDUAHER/KLR/R&D/CEC/S/UG/73/-2024-25