

Research Article

Copyright © All rights are reserved by Fahmy RM

Assessment of Effects of Different Mydriatics on Choroidal Thickness by Examining Anterior Chamber Parameters

Fahmy RM^{1*} and Hadeel Alamer²

¹Department of Ophthalmology, Faculty of Medicine, Cairo university, Egypt.

²Department of Optometry and Vision Sciences, Saudi Arabia

*Corresponding author: Fahmy RM, Department of Ophthalmology, Faculty of Medicine, Cairo university, Egypt.

Received Date: November 23, 2018

Published Date: January 11, 2019

Abstract

Background: Mydriatics drops have a broad range of applications in ocular examination and treatment. After administration, many changes can occur in the different parts of the eye including the choroidal layer which is a vascular layer localized between the outer sclera and inner retinal layers.

Purpose: To study effects of different mydriatics on choroidal thickness (CHT) by examining anterior chamber parameters (corneal thickness, corneal volume, corneal curvature, anterior chamber depth (ACD), anterior chamber volume (ACV) and anterior chamber angle (ACA).

Materials and methods: A total of 166 eyes of 83 students and employee aged 18-40 years old were enrolled in this cross-sectional study. The participants were divided randomly into 3 groups based on application of drops (tropicamide group, phenylephrine group and cyclopentolate group). All subjects underwent a full ophthalmic examination involving; visual acuity and refraction, Slit-lamp biomicroscopy, Fundus examination, IOP measurement using noncontact tonometry, anterior chamber parameters measurement using Pentacam Rotating Scheimpflug Camera and the choroidal thickness measurement by Optical coherence tomography OCT.

Result: Decrease in the peri-temporal, inner-temporal, sub foveal, inner-nasal and peri-nasal choroidal thickness after drops instillation in all groups were found to be significant ($p = 0.000$, $p = 0.000$, $p = 0.000$, $p = 0.000$ and $p = 0.000$ respectively), while increase in the anterior chamber depth was found to be significant with all mydriatics ($p = 0.00$).

Conclusion: The study showed that while cyclopentolate, tropicamide, and phenylephrine cause a decrease in choroidal thickness, they also lead to increase in anterior chamber depth.

Keywords: Mydriatics; Choroidal thickness; Anterior chamber parameters; Pentacam; OCT

Abbreviations: Cht Peri_Tem_PRE, POST: Peri-Temporal Choroidal Thickness Pre-& Post Drop Instillation; Cht_Inner_Tem_PRE, POST: Inner-Temporal Choroidal Thickness Pre-& Post Drop Instillation; Cht_Subfoveal_PRE, POST: Sub Foveal Choroidal Thickness Pre-& Post Drop Instillation; Cht_Inner_Nas_PRE, POST: Inner-Nasal Choroidal Thickness Pre-& Post Drop Instillation; Cht_Peri_Nas_PRE, POST: Peri-Nasal Choroidal Thickness Pre-&Post Drop instillation

Introduction

Mydriatic eye drops have a wide range of uses in ocular examination and management performing pupillary dilatation and or cycloplegia. Clinically, mydriatics are utilized to induce cycloplegia for refractive errors diagnosis, to obtain pupillary dilatation for fundus biomicroscopic examination, surgical procedures, and angiography, or to avoid synechia and adhesions in cases of chronic uveitis. After instillation of mydriatics, several changes manifest in

the iris thickness and volume as well as anterior chamber angle and depth associated with pupil dilation [1-3].

Choroid is a dark brown, highly vascular layer situated between the sclera and retina. It extends from the ora serrata up to the aperture of the optic nerve in the sclera. Its thickness can't be assessed accurately because of its extreme vascularity. It is thicker posteriorly (1\4mm) than anteriorly (1\10mm). The choroid is

adherent to the retina at two sites: at the margin of the optic nerve and at the scleral spur. It has many prime functions including nutrition of outer retinal layers [4,5]. Better comprehension of the choroidal framework may participate to the diagnosis and management of various ocular diseases. 3D OCT-2000 Spectral Domain OCT is a high-resolution, cross-sectional imaging technique that allows detailed assessment of retinal and choroidal thickness. With OCT, exact localization of pathologic features can be visualized in segmentation maps. Therefore, it becomes an important clinical and research tool for the diagnosis, follow up, treatment, and assessment of new treatment modalities for all diseases that affect the posterior pole of the eye. In many studies using OCT, it has been proved that choroidal thickness is influenced by various diseases like age related macular degeneration, malignant myopia and central serous chorioretinopathy [6-9].

The choroid as a part of the uveal tract as the iris may exhibit confirmed changes after mydriatic drops instillation. There has been restricted number of studies measuring choroidal thickness after mydriatic use. These studies revealed discordant results after measurements with efficient pupillary dilatation in healthy individuals, showing no change or thinning in choroid [10]. In our study, we have examined the hypothesis that the choroidal thickness will change with the application of the 3 commonly used mydriatics (cyclopentolate, tropicamide, and phenylephrine) and we examined whether these potential changes can be estimated through measurement of anterior chamber parameters.

Methods

The study was approved by the concerned Ethical Committee and informed consent followed the tenets of the Declaration of Helsinki. Subjects with best corrected visual acuity 20/25 or better, with refractive error ($\leq \pm 6.50$ SE) were eligible for this study. The exclusion criteria included those subjects who had a history of retinal diseases, ocular injury or surgery, any reasons for poor image quality of OCT such as unstable fixation or severe cataract, and age younger than 18 years. In this cross-sectional design study, a total of 166 eyes of 83 subjects aged 18-40 years were enrolled. The participants were divided randomly into 3 groups based on application of drops. Subjects who received a drop of 1% Tropicamide (anticholinergic blocking muscarinic receptors M4) 3 times at 5 min intervals were referred to as the Tropicamide

group, while subjects who received a drop of 2.5% phenylephrine (alpha agonist with sympathomimetic effect) 3 times at 5 min intervals were the phenylephrine group. Subjects who received a drop of 1% cyclopentolate (muscarinic antagonist) 3 times at 5 min intervals were defined as the cyclopentolate group. All subjects underwent a full ophthalmic examination involving; 1. Visual acuity and refraction. 2. Slit-lamp biomicroscopy. 3. Fundus examination. 4. IOP measurement using noncontact tonometry. 5. Anterior chamber parameters measurement using Pentacam Rotating Scheimpflug Camera (Pentacam HR – 70900 Oculus). 6. Choroidal thickness measurement by the OCT (3D OCT-2000 Spectral Domain OCT).

Procedure of image acquisition by pentacam and OCT has been previously described. [11,12] For each subject, corneal thickness, volume, curvature, anterior chamber depth, volume and angle were acquired through Pentacam before and 50 minutes after instillation of drops.

The sub foveal, temporal, and nasal choroidal thickness were defined as the vertical distance from the hyper reflective line of bruchs membrane to the hyper reflective line of the inner surface of the sclera, each vertical scan is separated by 1 mm (Figure 1). All subjects were imaged by the same examiner. OCT images of each subject were obtained before the administration of drops and after instillation. All scans were accomplished around the same time of the day, to avoid diurnal choroidal thickness fluctuations.

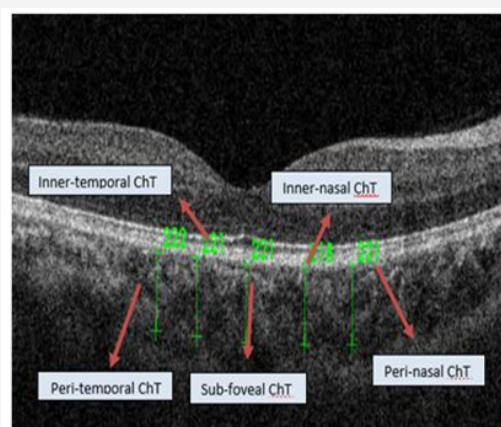


Figure 1: OCT images of each subject were obtained before the administration of drops and after instillation.

Statistical analysis

Table 1: Descriptive variables (ChT).

	N (μm)	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum	
				Lower Bound	Upper Bound			
peri_tem_PRE	CYCLO	48	218.7292	13.58933	214.7832	222.6751	195	255
	TROPICA	58	217.2586	14.76905	213.3753	221.1419	197	255
	PHENYL	60	208.15	16.96639	203.7671	212.5329	161	258
	Total	166	214.3916	15.91903	211.952	216.8311	161	258

peri_tem_POST	CYCLO	48	192.4167	16.37309	187.6624	197.1709	164	220
	TROPICA	58	193.6379	12.66533	190.3078	196.9681	170	230
	PHENYL	60	184.45	20.50583	179.1528	189.7472	115	236
	Total	166	189.9639	17.31137	187.3109	192.6168	115	236
inner_tem_PRE	CYCLO	48	220.0625	13.79702	216.0563	224.0687	191	258
	TROPICA	58	218.8276	19.62824	213.6666	223.9886	200	310
	PHENYL	60	209.4333	15.98343	205.3044	213.5623	167	258
	Total	166	215.7892	17.37564	213.1264	218.4519	167	310
inner_tem_POST	CYCLO	48	195.3958	22.82844	188.7671	202.0245	161	303
	TROPICA	58	194.3966	12.63376	191.0747	197.7184	172	233
	PHENYL	60	185.0333	20.765	179.6692	190.3975	118	237
	Total	166	191.3012	19.50119	188.3127	194.2897	118	303
subfoveal_PRE	CYCLO	48	222.6042	21.33396	216.4094	228.7989	191	333
	TROPICA	58	216.7241	14.91942	212.8013	220.647	195	256
	PHENYL	60	209.2333	15.74626	205.1656	213.301	168	250
	Total	166	215.7169	18.01778	212.9557	218.478	168	333
subfoveal_POST	CYCLO	48	195.5417	21.45055	189.3131	201.7703	160	286
	TROPICA	58	195.7759	12.36299	192.5252	199.0265	169	227
	PHENYL	60	185.3167	21.03467	179.8828	190.7505	115	236
	Total	166	191.9277	19.15663	188.992	194.8634	115	286
inner_nas_PRE	CYCLO	48	222.0833	22.3472	215.5944	228.5723	191	334
	TROPICA	58	216.431	15.75594	212.2882	220.5738	197	258
	PHENYL	60	208.3667	14.98809	204.4948	212.2385	170	251
	Total	166	215.1506	18.4291	212.3264	217.9748	170	334
inner_nas_POST	CYCLO	48	195	23.19391	188.2652	201.7348	161	305
	TROPICA	58	193.2414	12.88316	189.8539	196.6288	162	227
	PHENYL	60	184.5167	21.53554	178.9534	190.0799	113	237
	Total	166	190.5964	19.94872	187.5393	193.6535	113	305
peri_nas_PRE	CYCLO	48	219.1667	15.18304	214.758	223.5754	190	268
	TROPICA	58	217	15.06594	213.0386	220.9614	198	258
	PHENYL	60	208.5167	16.44456	204.2686	212.7647	171	255
	Total	166	214.5602	16.19631	212.0782	217.0423	171	268
peri_nas_POST	CYCLO	48	193.4375	17.00927	188.4985	198.3765	162	225
	TROPICA	58	193.0172	12.15036	189.8225	196.212	169	225
	PHENYL	60	184.6333	20.57147	179.3192	189.9475	116	236
	Total	166	190.1084	17.37327	187.446	192.7708	116	236

Table 2: Descriptive variables (Anterior chamber parameters).

		N	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
CT_PRE (µm)	CYCLO	48	557.9792	37.58819	547.0647	568.8936	497	659
	TROPICA	58	556.7241	30.72332	548.6459	564.8024	497	628
	PHENYL	60	546.55	34.07341	537.7479	555.3521	492	645
	Total	166	553.4096	34.2159	548.1662	558.6531	492	659
CT_POST (µm)	CYCLO	48	563.0208	36.31745	552.4753	573.5663	504	658
	TROPICA	58	556.7241	28.34115	549.2722	564.1761	508	605
	PHENYL	60	553.2167	32.58995	544.7978	561.6355	500	654
	Total	166	557.2771	32.38305	552.3145	562.2397	500	658

CV_PRE (mm ³)	CYCLO	48	60.4688	4.0416	59.2952	61.6423	51.5	69.9
	TROPICA	58	62.519	13.60656	58.9413	66.0966	54.1	161
	PHENYL	60	59.2633	3.68151	58.3123	60.2144	51.5	69.3
	Total	166	60.7494	8.68233	59.4189	62.0799	51.5	161
CV_POST (mm ³)	CYCLO	48	60.1813	4.65017	58.831	61.5315	46	69
	TROPICA	58	62.0414	13.16794	58.579	65.5037	52.5	157
	PHENYL	60	59.48	3.6279	58.5428	60.4172	53.4	70.7
	Total	166	60.5777	8.48545	59.2773	61.8781	46	157
CC_PRE (D)	CYCLO	48	42.7875	1.14884	42.4539	43.1211	40.1	45.2
	TROPICA	58	42.6586	1.74276	42.2004	43.1169	39.7	46
	PHENYL	60	43.2433	2.3796	42.6286	43.858	40.3	59.1
	Total	166	42.9072	1.87534	42.6198	43.1946	39.7	59.1
CC_POST (D)	CYCLO	48	42.6021	1.91283	42.0467	43.1575	32.7	45.4
	TROPICA	58	42.6207	1.80582	42.1459	43.0955	38.7	45.9
	PHENYL	60	43.015	1.1558	42.7164	43.3136	40.3	45.3
	Total	166	42.7578	1.63834	42.5068	43.0089	32.7	45.9
ACD_PRE (mm)	CYCLO	48	3.1102	0.256	3.0359	3.1845	2.5	3.74
	TROPICA	58	3.079	0.28814	3.0032	3.1547	2.37	3.65
	PHENYL	60	6.1028	23.61932	0.0013	12.2044	2.52	186
	Total	166	4.181	14.19973	2.0049	6.357	2.37	186
ACD_POST (mm)	CYCLO	48	3.1671	0.25283	3.0937	3.2405	2.5	3.84
	TROPICA	58	3.164	0.25606	3.0966	3.2313	2.64	3.8
	PHENYL	60	3.0947	0.23134	3.0349	3.1544	2.52	3.65
	Total	166	3.1398	0.2473	3.1019	3.1777	2.5	3.84
ACV_PRE (mm ³)	CYCLO	48	181.8125	33.13394	172.1914	191.4336	125	269
	TROPICA	58	173.0345	28.53312	165.5321	180.5369	112	244
	PHENYL	60	175.0345	38.46369	165.0983	184.9707	3.07	308
	Total	166	176.2956	33.70696	171.1301	181.4611	3.07	308
ACV_POST (mm ³)	CYCLO	48	189.4167	33.6065	179.6584	199.175	107	267
	TROPICA	58	185.569	30.31652	177.5976	193.5403	112	275
	PHENYL	60	184.65	27.00836	177.673	191.627	125	247
	Total	166	186.3494	30.06737	181.7417	190.9571	107	275
ACA_PRE (°)	CYCLO	48	38.5104	4.23156	37.2817	39.7391	26.8	47.9
	TROPICA	58	38.3017	3.93212	37.2678	39.3356	30.9	47.1
	PHENYL	60	39.3767	3.96341	38.3528	40.4005	26.7	49.9
	Total	166	38.7506	4.03596	38.1321	39.3691	26.7	49.9
ACA_POST (°)	CYCLO	48	38.8604	6.50449	36.9717	40.7491	25.9	53.4
	TROPICA	58	46.2431	40.07739	35.7053	56.7809	20.4	196
	PHENYL	60	39.15	5.25007	37.7938	40.5062	26	49
	Total	166	41.5446	24.26349	37.8263	45.2629	20.4	196

All data analyses were performed by using the Statistical Package for the Social Sciences (SPSS) for Windows version 20.0. All variables were presented as mean \pm standard deviation (Table 1-2). A Paired *t*-test was done to compare the measurements of anterior chamber parameters and choroidal thickness (ChT) of the Tropicamide group (Table 3), Phenylephrine group (Table 4) and

Cyclopentolate group (Table 5). The Homogeneity of variances was confirmed by using Levene's test. For parametric statistics, the data were normally distributed and were analyzed using one-way ANOVA test (Table 6) to compare the groups. When a significant result was obtained, the Tukey test was used for Post hoc comparisons (Table 7). A *p* value < 0.05 was considered statistically significant.

Table 3: Paired t-test (Tropicamide group).

		Mean	Std. Deviation	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Pair 1	CT_PRE - POST	0	17.89639	-4.70562	4.70562	0	57	1
Pair 2	CV_PRE - POST	0.47759	18.96852	-4.50993	5.4651	0.192	57	0.849
Pair 3	CC_PRE - POST	0.03793	0.24909	-0.02756	0.10343	1.16	57	0.251
Pair 4	ACD_PRE - POST	-0.085	0.08146	-0.10642	-0.06358	-7.947	57	.000**
Pair 5	ACV_PRE - POST	-12.53448	16.57436	-16.89249	-8.17648	-5.759	57	.000**
Pair 6	ACA_PRE - POST	-7.94138	39.70284	-18.38071	2.49795	-1.523	57	0.133
Pair 7	peri_tem_PRE- POST	23.62069	19.34709	18.53363	28.70775	9.298	57	.000**
Pair 8	inner_tem_PRE- POST	24.43103	22.58171	18.49348	30.36859	8.239	57	.000**
Pair 9	Sub foveal_PRE- POST	20.94828	19.27677	15.87971	26.01684	8.276	57	.000**
Pair 10	Inner_nas_PRE- POST	23.18966	20.22458	17.87187	28.50744	8.732	57	.000**
Pair 11	peri_nas_PRE- POST	23.98276	19.50753	18.85352	29.112	9.363	57	.000**

* Significant. ** . Highly significant.

Table 4: Paired t-test (Phenylephrine group).

		Mean	Std. Deviation	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Pair 1	CT_PRE - POST	-5.81395	16.92175	-11.0217	-0.60621	-2.253	42	.030*
Pair 2	CV_PRE - POST	-0.21628	0.94565	-0.50731	0.07475	-1.5	42	0.141
Pair 3	CC_PRE - POST	0.35116	2.57195	-0.44037	1.14269	0.895	42	0.376
Pair 4	ACD_PRE -POST	4.22047	27.90503	-4.36744	12.80837	0.992	42	0.327
Pair 5	ACV_PRE -POST	-11.81233	26.15752	-19.86242	-3.76223	-2.961	42	.005**
Pair 6	ACA_PRE - POST	0.80465	4.94055	-0.71583	2.32513	1.068	42	0.292
Pair 7	peri_tem_PRE -POST	24.32558	14.912	19.73635	28.91482	10.697	42	.000**
Pair 8	inner_tem_PRE- POST	25.97674	13.80043	21.7296	30.22389	12.343	42	.000**
Pair 9	subfoveal_PRE -POST	25.2093	14.2621	20.82008	29.59853	11.591	42	.000**
Pair 10	inner_nas_PRE -POST	24.83721	16.18925	19.85489	29.81953	10.06	42	.000**
Pair 11	peri_nas_PRE -POST	24.76744	16.4575	19.70257	29.83231	9.869	42	.000**

Table 5: Paired t-test (Cyclopentolate group).

		Mean	Std. Deviation	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Pair 1	CT_PRE - POST	-5.04167	15.44098	-9.52526	-0.55807	-2.262	47	.028*
Pair 2	CV_PRE - POST	0.2875	2.45293	-0.42476	0.99976	0.812	47	0.421
Pair 3	CC_PRE - POST	0.18542	1.47979	-0.24427	0.6151	0.868	47	0.39
Pair 4	ACD_PRE - POST	-0.05688	0.14569	-0.09918	-0.01457	-2.705	47	.009**
Pair 5	ACV_PRE - POST	-7.60417	17.84417	-12.78557	-2.42276	-2.952	47	.005**
Pair 6	ACA_PRE - POST	-0.35	6.10967	-2.12406	1.42406	-0.397	47	0.693
Pair 7	peri_tem_PRE- POST	26.3125	18.79357	20.85542	31.76958	9.7	47	.000**
Pair 8	inner_tem_PRE- POST	24.66667	25.09754	17.3791	31.95423	6.809	47	.000**
Pair 9	subfoveal_PRE- POST	27.0625	27.64933	19.03397	35.09103	6.781	47	.000**
Pair 10	inner_nas_PRE- POST	27.08333	20.56627	21.11151	33.05516	9.124	47	.000**
Pair 11	peri_nas_PRE -POST	25.72917	20.53408	19.76669	31.69164	8.681	47	.000**

Table 6: One-way ANOVA test.

		Sum of Squares	df	Mean Square	Sig.
peri_tem_PRE	Between Groups	3717.298	2	1858.649	.001**
	Within Groups	38096.25	163	233.719	
	Total	41813.548	165		
peri_tem_POST	Between Groups	2895.87	2	1447.935	.007**
	Within Groups	46551.913	163	285.595	
	Total	49447.783	165		
inner_tem_PRE	Between Groups	3835.799	2	1917.899	.001**
	Within Groups	45979.822	163	282.085	
	Total	49815.62	165		
innet_tem_POST	Between Groups	3717.648	2	1858.824	.007**
	Within Groups	59031.292	163	362.155	
	Total	62748.94	165		
subfoveal_PRE	Between Groups	4857.894	2	2428.947	.000**
	Within Groups	48707.799	163	298.821	
	Total	53565.693	165		
subfoveal_POST	Between Groups	4108.146	2	2054.073	.003**
	Within Groups	56442.986	163	346.276	
	Total	60551.133	165		
inner_nas_PRE	Between Groups	5163.411	2	2581.705	.000**
	Within Groups	50875.824	163	312.122	
	Total	56039.235	165		
inner_nas_POST	Between Groups	3554.354	2	1777.177	.011**
	Within Groups	62107.604	163	381.028	
	Total	65661.958	165		
peri_nas_PRE	Between Groups	3555.248	2	1777.624	.001**
	Within Groups	39727.65	163	243.728	
	Total	43282.898	165		
peri_nas_POST	Between Groups	2821.32	2	1410.66	.009**
	Within Groups	46980.729	163	288.225	
	Total	49802.048	165		

Table 7: Post Hoc Test.

Dependent Variable	(I) Groups	(J) Groups	Mean Difference (I-J)	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
peri_tem_PRE	CYCLO	TROPICA	1.47055	0.875	-5.5854	8.5265
		PHENYL	10.57917*	.001**	3.5767	17.5817
	TROPICA	CYCLO	-1.47055	0.875	-8.5265	5.5854
		PHENYL	9.10862*	.004**	2.4499	15.7673
	PHENYL	CYCLO	-10.57917*	.001**	-17.5817	-3.5767
		TROPICA	-9.10862*	.004**	-15.7673	-2.4499
peri_tem_POST	CYCLO	TROPICA	-1.22126	0.927	-9.0211	6.5785
		PHENYL	7.96667*	.042**	0.226	15.7074
	TROPICA	CYCLO	1.22126	0.927	-6.5785	9.0211
		PHENYL	9.18793*	.010**	1.8273	16.5486
	PHENYL	CYCLO	-7.96667*	.042*	-15.7074	-0.226
		TROPICA	-9.18793*	.010**	-16.5486	-1.8273

inner_tem_PRE	CYCLO	TROPICA	1.23491	0.925	-6.5168	8.9866
		PHENYL	10.62917*	.004**	2.9362	18.3222
	TROPICA	CYCLO	-1.23491	0.925	-8.9866	6.5168
		PHENYL	9.39425*	.008**	2.079	16.7095
	PHENYL	CYCLO	-10.62917*	.004**	-18.3222	-2.9362
		TROPICA	-9.39425*	.008**	-16.7095	-2.079
innet_tem_POST	CYCLO	TROPICA	0.99928	0.961	-7.784	9.7825
		PHENYL	10.36250*	.015**	1.6458	19.0792
	TROPICA	CYCLO	-0.99928	0.961	-9.7825	7.784
		PHENYL	9.36322*	.023**	1.0745	17.652
	PHENYL	CYCLO	-10.36250*	.015**	-19.0792	-1.6458
		TROPICA	-9.36322*	.023**	-17.652	-1.0745
subfoveal_PRE	CYCLO	TROPICA	5.88003	0.192	-2.0983	13.8584
		PHENYL	13.37083*	.000**	5.4529	21.2888
	TROPICA	CYCLO	-5.88003	0.192	-13.8584	2.0983
		PHENYL	7.4908	0.052	-0.0384	15.02
	PHENYL	CYCLO	-13.37083*	.000**	-21.2888	-5.4529
		TROPICA	-7.4908	0.052	-15.02	0.0384
subfoveal_POST	CYCLO	TROPICA	-0.2342	0.998	-8.8227	8.3543
		PHENYL	10.22500*	.014**	1.7015	18.7485
	TROPICA	CYCLO	0.2342	0.998	-8.3543	8.8227
		PHENYL	10.45920*	.007**	2.3542	18.5642
	PHENYL	CYCLO	-10.22500*	.014**	-18.7485	-1.7015
		TROPICA	-10.45920*	.007**	-18.5642	-2.3542
inner_nas_PRE	CYCLO	TROPICA	5.6523	0.232	-2.5017	13.8063
		PHENYL	13.71667*	.000**	5.6245	21.8089
	TROPICA	CYCLO	-5.6523	0.232	-13.8063	2.5017
		PHENYL	8.06437*	.038*	0.3695	15.7593
	PHENYL	CYCLO	-13.71667*	.000**	-21.8089	-5.6245
		TROPICA	-8.06437*	.038*	-15.7593	-0.3695
inner_nas_POST	CYCLO	TROPICA	1.75862	0.889	-7.2506	10.7678
		PHENYL	10.48333*	.017**	1.5424	19.4243
	TROPICA	CYCLO	-1.75862	0.889	-10.7678	7.2506
		PHENYL	8.72471*	.043*	0.2227	17.2267
	PHENYL	CYCLO	-10.48333*	.017**	-19.4243	-1.5424
		TROPICA	-8.72471*	.043*	-17.2267	-0.2227
peri_nas_PRE	CYCLO	TROPICA	2.16667	0.757	-5.0388	9.3721
		PHENYL	10.65000*	.002**	3.4991	17.8009
	TROPICA	CYCLO	-2.16667	0.757	-9.3721	5.0388
		PHENYL	8.48333*	.010**	1.6836	15.2831
	PHENYL	CYCLO	-10.65000*	.002**	-17.8009	-3.4991
		TROPICA	-8.48333*	.010**	-15.2831	-1.6836
peri_nas_POST	CYCLO	TROPICA	0.42026	0.991	-7.4154	8.2559
		PHENYL	8.80417*	.022**	1.0279	16.5804

	TROPICA	CYCLO	-0.42026	0.991	-8.2559	7.4154
		PHENYL	8.38391*	.022**	0.9894	15.7784
	PHENYL	CYCLO	-8.80417*	.022**	-16.5804	-1.0279
		TROPICA	-8.38391*	.022**	-15.7784	-0.9894

Result

Demographic data

The mean age was 21.6 ± 1.6 years (age range: 18-23 years). The subjects were divided randomly into 3 groups based on the application of the drops. Groups were comprised of tropicamide group (n=58;34.7%), the phenylephrine group (n=60;35.9%), and cyclopentolate group (n=48;28.7%). The mean spherical equivalent was measured as -1.37 ± 1.73 diopters in the tropicamide group, -1.46 ± 1.83 diopters in the phenylephrine group, and -1.62 ± 1.63 diopters in the cyclopentolate group. There were no significant differences in the demographic characteristics and ocular parameters between the 3 groups. Demographics data in all groups were summarized in (Table 8), including the mean age, best corrected visual acuity, and the spherical equivalent power.

Table 8: Demographic data.

Cyclopentolate	Phenylephrine	Tropicamide	
n = 48	n = 60	n = 58	
21.8 ± 2.2	21.4 ± 1.1	21.8 ± 1.6	Age (year)
0	0	0	BCVA (log Mar)
-1.62 ± 1.63	-1.46 ± 1.83	-1.37 ± 1.73	SEQ (diopters)

BCVA: Best Corrected Visual Acuity (0.00 in log Mar = Snellen score of 6/6 = (20/20)); SEQ: mean spherical equivalent. Variables are expressed as mean \pm standard deviation.

Anterior chamber parameters

The Corneal thickness in tropicamide group showed no significant difference from 556.72 ± 30.72 μ m at baseline to 556.72 ± 28.34 μ m after drug administration, corneal thickness increased from 546.55 ± 30.07 μ m to 553.21 ± 32.58 μ m in the phenylephrine group and increased from 557.97 ± 37.58 μ m to 563.02 ± 36.31 μ m in the cyclopentolate group. Moreover, the corneal volume in tropicamide group showed no significant change from 62.51 ± 13.6 mm³ at baseline to 62.04 ± 13.16 mm³ after drug administration, from 59.26 ± 3.68 mm³ to 59.48 ± 3.62 mm³ in the phenylephrine group, and from 60.46 ± 4.04 mm³ to 60.18 ± 4.65 mm³ in the cyclopentolate group.

When it comes to the corneal curvature in tropicamide group it showed no significant change from 42.65 ± 1.74 Diopters (D) at baseline to 42.62 ± 1.91 D after drug administration, from 43.24 ± 2.37 D to 43.01 ± 1.15 D in the phenylephrine group, and from 42.78 ± 1.14 D to 42.60 ± 1.91 D in the cyclopentolate group.

The results showed that there are no significant changes in the corneal thickness, volume, and curvature after drops instillation in the 3 groups.

The anterior chamber depth showed no significant changes from 3.07 ± 0.28 mm at baseline to 3.16 ± 0.25 mm after drug administration in the tropicamide group. Anterior chamber

depth decreased from 6.10 ± 23.61 mm to 3.09 ± 0.23 mm in the phenylephrine group. However, it showed no changes from 3.11 ± 0.25 mm to 3.16 ± 0.25 mm in the cyclopentolate group.

However, the anterior chamber volume increased from 173.03 ± 28.35 mm³ at baseline to 185.56 ± 30.31 mm³ after drops administration in tropicamide group, from 175.03 ± 38.46 mm³ to 184.65 ± 27 mm³ in the phenylephrine group, and from 181.81 ± 33.13 mm³ to 189.41 ± 33.6 mm³ in the cyclopentolate group, respectively. The results showed that the ACV increased significantly in the all groups (p=0.000).

Furthermore, the angle of the anterior chamber in tropicamide group increased from $38.30 \pm 3.93^\circ$ at baseline to $46.24 \pm 40.07^\circ$ after drug administrations, the angle of the anterior chamber showed no significant change from $39.37 \pm 3.96^\circ$ to $39.15 \pm 5.25^\circ$ in the phenylephrine group, and from $38.51 \pm 4.23^\circ$ to $38.86 \pm 6.50^\circ$ in the cyclopentolate group.

Choroidal thickness

Concerning the peri-temporal choroidal thickness, we found that there was a significant choroidal thinning in all groups, (p = 0.00). The measurement before and after drops instillation were 217.25 ± 14.76 μ m and 193.63 ± 12.66 μ m in the tropicamide group, 208.15 ± 16.96 μ m and 184.65 ± 27 μ m in the phenylephrine group, 218.72 ± 13.58 μ m and 192.41 ± 16.37 μ m in the cyclopentolate group, respectively.

The subfoveal choroidal thickness measurement before and after drops instillation were, 216.72 ± 14.91 μ m and 195.77 ± 36 μ m in the tropicamide group, 209.23 ± 15.74 μ m and 185.31 ± 21.03 μ m in the phenylephrine group, 222.60 ± 21.33 μ m and 195.54 ± 21.45 μ m in the cyclopentolate group, respectively. These results indicate that the subfoveal choroidal thickness decrease significantly in all groups, (p=0.00).

Moreover, the peri-nasal choroidal thickness measurement demonstrated a significant reduction in the thickness before and after drops instillation in all groups, (p=0.00). Changes in the anterior chamber parameters and choroidal thickness before and after drops instillation in all groups are demonstrated in (Table 9).

Table 9: Changes of anterior chamber parameters and choroidal thickness before and after drops instillation.

Cyclopentolate	Phenylephrine	Tropicamide	
n= 48	n= 60	n= 58	
			CT (μ m)
557.97 ± 37.58	557.97 ± 37.58	557.97 ± 37.58	Before
563.02 ± 36.31	563.02 ± 36.31	563.02 ± 36.31	After
0.28	0.28	0.28	P value
			CV (mm ³)

60.46 ± 4.04	60.46 ± 4.04	60.46 ± 4.04	Before
60.18 ± 4.65	60.18 ± 4.65	60.18 ± 4.65	After
0.42	0.42	0.42	<i>P</i> value
			CC (D)
42.78 ± 1.14	42.78 ± 1.14	42.78 ± 1.14	Before
42.6 ± 1.91	42.6 ± 1.91	42.6 ± 1.91	After
0.39	0.39	0.39	<i>P</i> value
			ACV (mm ³)
173.03 ± 28.53	173.03 ± 28.53	173.03 ± 28.53	Before
185.56 ± 30.31	185.56 ± 30.31	185.56 ± 30.31	After
0	0	0	<i>P</i> value
			ACD (mm)
3.11 ± 0.25	6.1 ± 23.61	3.07 ± 0.28	Before
3.16 ± 0.25	3.09 ± 0.23	3.16 ± 0.25	After
0.009	0.009	0.009	<i>P</i> value
			ACA (°)
38.51 ± 4.23	38.51 ± 4.23	38.51 ± 4.23	Before
38.86 ± 6.5	38.86 ± 6.5	38.86 ± 6.5	After
0.69	0.69	0.69	<i>P</i> value
			ChT peri-temporal (µm)
218.72 ± 13.58	208.15 ± 16.96	217.25 ± 14.76	Before
192.41 ± 16.37	184.45 ± 20.5	196.36 ± 12.66	After
0	0	0	<i>P</i> value
			ChT inner-temporal (µm)
220.06 ± 13.79	209.43 ± 15.98	218.82 ± 19.62	Before
195.39 ± 22.82	185.03 ± 20.76	194.39 ± 12.63	After
0	0	0	<i>P</i> value
			ChT subfoveal (µm)
222.6 ± 21.33	209.23 ± 15.74	216.72 ± 14.91	Before
195.54 ± 21.45	185.31 ± 21.03	195.77 ± 12.36	After
0	0	0	<i>P</i> value
			ChT inner-nasal (µm)
222.08 ± 22.34	208.36 ± 14.98	216.43 ± 15.75	Before
195 ± 23.19	184.51 ± 21.53	193.24 ± 12.88	After
0	0	0	<i>P</i> value
			ChT peri-nasal (µm)
219.16 ± 15.18	238.38 ± 23.06	217 ± 15.06	Before
193.43 ± 17	184.63 ± 20.57	193.01 ± 12.15	After
0	0	0	<i>P</i> value

CT: corneal thickness, CV: corneal volume, CC: corneal curvature, ACV: anterior chamber volume, ACD: anterior chamber depth, ACA: anterior chamber angle, and ChT: choroidal thickness. Variables are expressed as mean ± standard deviation. Level of significance $p < 0.05$, a paired t-test.

Discussion

Current study carried out on 166 eyes of 83 subjects; found that all mydriatic agents led to significant choroidal thinning. It showed that there were changes at the level of the anterior chamber parameters. Especially ACV that increased significantly in all groups.

N Kara et al. [10] conducted a study on 90 healthy subjects to investigate the effect of 2 commonly used mydriatics (tropicamide and phenylephrine) on ChT using (OCT), and showed that the subfoveal choroidal thickness was significantly decreased after drop instillation which is confident with our findings. [10] Recently, performed a study examining the effect of the 3 commonly used mydriatics upon the choroidal thickness and its relationship with anterior segment parameters in 120 eyes of 240 healthy adult subjects using (OCT), and proved that the 3 drops cause choroidal thinning with an increase in volume and depth of anterior chamber, which is supporting our research data [13].

A study carried out by BP Sander, et al. [14] studying the effect of 2% homatropine (parasympatholytic) and 2.5% phenylephrine (sympathomimetic) upon the ChT in 40 eyes of healthy adult subjects revealed that the instillation of 2% homatropine resulted in a small but significant increase in subfoveal and parafoveal ChT however no significant changes in ChT were observed after 2.5% phenylephrine instillation, which is inconsistent with our results (small sample size & different age group) [14].

However, another study done by M Kim, et al. [15] on 58 healthy eyes of 29 subjects demonstrated that tropicamide and phenylephrine have no significant influence on clinical measurement of ChT, which is not in agreement with our findings (small sample size & different ethnicity) [15].

Conclusion

In conclusion, results succeeded to evaluate the effects of mydriatics on choroidal thickness and anterior chamber parameters.

Acknowledgement

None.

Conflicts of Interest

The authors declare no potential conflicts of interest with respect to the authorship, and/or publication of this article.

References

1. SW Cheung, R Chan, RCS Cheng, P Cho (2009) Effect of cycloplegia on axial length and anterior chamber depth measurements in children. *Clinical and Experimental Optometry* 92(6): 476-481.
2. F Aptel, P Denis (2010) Optical coherence tomography quantitative analysis of iris volume changes after pharmacologic mydriasis. *Ophthalmology* 117(1): 3-10.
3. AP Ribeiro, RM Crivelaro, PP Teixeira, DY Trujillo, PJ Guimaraes, et al. (2014) Effects of different mydriatics on intraocular pressure, pupil diameter, and ruminal and intestinal motility in healthy sheep. *Vet Ophthalmol* 17(6): 397-402.
4. DL Nickla, J Wallman (2010) The multifunctional choroid. *Prog Retin Eye Res* 29(2): 144-168.

5. E Ahmed (2011) Comprehensive manual of ophthalmology (1st ed.). New Delhi: Jaypee Brothers.
6. RF Spaide (2009) Enhanced depth imaging optical coherence tomography of retinal pigment epithelial detachment in age related macular degeneration. *Am J Ophthalmol* 147(4): 644-652.
7. JC Mwanza, FE Sayyad, MR Banitt, DL Budenz (2013) Effect of pupil dilation on macular choroidal thickness measured with spectral domain optical coherence tomography in normal and glaucomatous eyes. *International Ophthalmology* 33(4): 335-341.
8. T Fujiwara, Y Imamura, R Margolis, JS Slakter, RF Spaide (2009) Enhanced depth imaging optical coherence tomography of the choroid in highly myopic eyes. *Am j Ophthalmol* 148(3): 445-450.
9. I Maruko, T Iida, Y Sugano, A Ojima, T Sekiryu (2011) Subfoveal choroidal thickness in fellow eyes of patients with central serous chorioretinopathy. *Retina* 31(8): 1603-1608.
10. N Kara, A Demirok, G Karatas, A Basci, G Tatar Demircan A et al. (2014) Effects of two commonly used mydriatics on choroidal thickness: direct and crossover effects. *j Ocul Pharmacol Ther* 30(4): 366-370.
11. Jain R, Grewal S (2009) Pentacam: Principle and Clinical Applications. *Current Journal of Glaucoma Practice with DVD*: 20-32.
12. 3D OCT-2000 Spectral Domain OCT | Topcon Medical Systems, Inc. (2016). Topconmedical.com.
13. I Yuvaci, E Pangal, S Yuvaci, N Bayram, M Ataş et al (2015) An Evaluation of Effects of Different Mydriatics on Choroidal Thickness by Examining Anterior Chamber Parameters: The Scheimpflug Imaging and Enhanced Depth Imaging-OCT Study. *J Ophthalmol* 2015(6): 981274.
14. BP Sander, MJ Collins, SA (2014) Read The effect of topical adrenergic and anticholinergic agents on the choroidal thickness of young health adults. *Exp Eye Res* 128:181-189.
15. M Kim, HJ Kwon, SC Lee (2012) Influence of mydriatics on choroidal thickness measurement using enhanced depth imaging-OCT. *Optom Vis Sci* 89(8): 1150-1155.