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Original Research Article

COMPARISON OF ACUTE EFFECT OF CYCLOPENTOLATE AND TROPICAMIDE ON INTRAOCULAR PRESSURE ON ALBINO RABBITS

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ABSTRACT

Cycloplegic agents like cyclopentolate and tropicamide eyedrops are broadly used in optometric exams to dilate pupils and temporarily stop accommodation. However, they can cause slight increases in intraocular pressure (IOP). Factors such as age, eye health, and refractive status influence these IOP changes. Despite their common use, few studies have compared their effects on IOP specifically in Nigerian patients. This study aimed to compare the effects of topical cyclopentolate and tropicamide on IOP among healthy albino rabbits. A total of 10 rabbits were used and randomly assigned into two groups. Cyclopentolate eye drop was instilled in one group and topical tropicamide instilled in the other group. IOP was measured using a calibrated I-care tonometer (iCare Finland Oy, Vantaa, Finland) at baseline, 5minutes, 10minutes, 30 minutes, 60 minutes, 90 minutes and 120 minutes after drug administration. Results showed an initial slight increase in IOP following administration of both agents, with cyclopentolate showing a greater mean rise in IOP compared to tropicamide. While the initial IOP increases were statistically significant within both groups, they remained within physiologic limits for the majority of subjects. These findings suggest that although both agents may cause transient IOP elevations, cyclopentolate tends to exert a stronger pressure effect. The study underscores the importance of IOP monitoring after cycloplegic use, especially in patients at risk, and contributes locally relevant data to inform clinical decisions.

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INTRODUCTION

The pressure exerted by the contents within the eye is usually referred to as intraocular pressure (IOP). Under normal physiological conditions, IOP falls within the range of 10–21 mmHg and this level is relatively consistent across different age groups and sexes, although minor fluctuations may occur throughout the day and across seasons [1]. It has been observed that maintaining IOP within this appropriate physiological range is essential for preserving the structural integrity of the eye, which in turn ensures optimal light refraction and visual function. As a key clinical parameter, IOP measurement plays a crucial role in both the early detection and ongoing management of glaucoma [2]. According to Rengstorff and Doughty [3] adverse reactions associated with mydriatic and cycloplegic agents occur infrequently relative to how widely these drugs are administered. When side effects do arise, they are typically influenced by the administered dose or other contributing factors. Ocular manifestations may include elevated intraocular pressure, conjunctival and corneal pigmentation, pigment deposits in the anterior chamber, obstruction of the lacrimal duct, macular edema, damage to the corneal endothelium, hyperemia, allergic reactions, ocular

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discomfort, and visual blurring. Murgatroyd and Bembridge [1] further discussed that IOP is normally regulated by changes in the volume of the aqueous humour and that acute increases in IOP are caused by increases in episcleral venous pressure, determined by Central Venous Pressure (CVP). A prolonged rise in IOP can lead to glaucomatous optic neuropathy and loss of visual field [4].

Cycloplegic and mydriatic agents play a fundamental role in ophthalmic practice, serving as valuable tools in the diagnosis and management of various ocular conditions. Currently, five agents fall under this category: atropine sulfate, homatropine hydrobromide, scopolamine hydrobromide, tropicamide, and cyclopentolate hydrochloride. Among these, cyclopentolate has demonstrated distinct advantages over the other available mydriatic and cycloplegic options [5].

Cyclopentolate is an agent that induces both accommodation paralysis and pupillary dilation, and its use has become widespread across global ophthalmic practice. Given its comparatively brief duration of action combined with its reliable ability to achieve cycloplegia, cyclopentolate is especially well-suited for use in pediatric refractive error screening [6].

Tropicamide, a synthetic derivative of tropic acid, is recognized as a well-tolerated agent for cycloplegic refraction. It is notable for its quick onset of action, with the cycloplegic effect typically manifesting within 20 to 30 minutes following administration, while recovery generally occurs approximately 6 hours afterward. Reported ocular side effects include a stinging sensation, corneal irritation, and a rise in intraocular pressure [7].

The rabbit eye has become a widely adopted model in ophthalmic or optometry research, largely due to the ease of handling these animals, their relatively low cost compared to other mammalian models, and the anatomical resemblance of their eyes to those of humans [8]. When cyclopentolate was administered to rabbits, pupillary dilation was achieved more rapidly, occurring between 10 and 25 minutes post-treatment, without any notable elevation in IOP, and the mydriatic effect persisted for a duration of 10 to 12 hours [9].

Accurate assessment of intraocular pressure (IOP) is vital during eye exams because even small increases can damage the optic nerve, especially in people at risk. Cyclopentolate and tropicamide are commonly used to dilate pupils and relax the eye and can both cause a temporary rise in IOP [10,11]. However, this increase is usually small (about 0.4 to 1.0 mmHg), in some cases especially in children or glaucoma prone patients, it can increase more significantly, even by 5 mmHg or more [12]. It has been observed that cyclopentolate tends to raise IOP more than tropicamide, which appears safer, particularly for patients with open-angle glaucoma [11]. It was also observed that the combined use of 1% cyclopentolate and 1% tropicamide increased IOP in hyperopic children but not in myopic ones [10].

Despite this, there is a lack of direct comparisons between the two drugs effects on IOP, especially across different age groups, eye conditions, and associated risk factors. This creates uncertainty for eye care professionals when choosing the safest drug for each patient. The aim of this study was to investigate and compare the acute effect of cyclopentolate and tropicamide on the Intra ocular pressure in albino rabbit.

MATERIALS AND METHODS

The materials and instruments used for this study were: iCare TonoLab rebound tonometer (iCare Finland Oy, Vantaa, Finland) with disposable probe tips, cyclopentolate hydrochloride 1% ophthalmic solution, tropicamide 1% ophthalmic solution, sterile gauze, stainless steel animal housing cages, and standard rabbit chow.

Method

Quasi-experimental design was used compare the acute effects of cyclopentolate and tropicamide eyedrops on IOP in healthy adult albino rabbits (New Zealand White strain, aged 6 to12 months, weighing 3 to 5 kg), using a within-subject repeated measures design where each animal served as its own control. Animals were individually housed under controlled conditions (20–24°C, 50–60% humidity, 12-hour light/dark cycle) with a 48-hour acclimatization period prior to experimentation. All eyes were carefully examined prior to the instillation of eyedrops to exclude pre-existing ocular pathology, and all measurements were performed by a single trained individual throughout to ensure uniformity.

Baseline IOP Measurement

Baseline IOP was measured using a calibrated iCare TonoLab rebound tonometer (iCare Finland Oy, Vantaa, Finland) with disposable probe tips. Three consecutive readings were taken per eye and were averaged to obtain the baseline value. This was recorded prior to drug administration and served as the control for each animal.

Drug Administration and Post-Administration IOP Measurements

One drop of either cyclopentolate hydrochloride 1%w/v or tropicamide 1%w/v was instilled into the inferior conjunctival fornix of both eyes under strict aseptic technique. Digital pressure was applied to the lacrimal puncta for 30 seconds post-instillation in order to limit systemic absorption. IOP was subsequently measured unilaterally at different time interval (5, 10, 30, 60, 90, and 120 minutes) post-instillation using the same technique as baseline. Environmental conditions were kept constant throughout, and animals were monitored for any signs of ocular discomfort.

Statistical Analysis

The data of this study were expressed as mean ± standard deviation (SD), represented in tables, figures and analyzed

using t-test and ANOVA. The statistical value, $p < 0.05$ was set as the statistically significant difference level.

RESULTS

A total of 10 healthy adult albino rabbits (New Zealand White strain) comprising 10 right eyes were used in this study. The animals were equally and randomly allocated into two treatment groups, that is, five rabbits received cyclopentolate hydrochloride 1%w/v, while the remaining five rabbits received tropicamide 1%w/v. Intraocular pressure (IOP) was recorded unilaterally using the right eye at baseline (0 min) and at 5, 10, 30, 60, 90, and 120 minutes post-instillation. All animals completed the study protocol without any observable adverse events or clinical signs of ocular distress.

Effect of Cyclopentolate on IOP

Table 1 presents the individual IOP readings of five rabbits before and after the instillation of cyclopentolate hydrochloride 1%w/v in the right eye. At baseline, IOP values measured across the five animals ranged from 14 to 18 mmHg with a group mean of 16.8 ± 1.79 mmHg. After the drug instillation, a progressive and consistent elevation in IOP was observed across all animals. The mean IOP increased to 20.4 ± 1.95 mmHg at 5 minutes, increased further to 21.0 ± 1.41 mmHg at 10 minutes, and reached its peak value of 21.8 ± 1.10 mmHg at 30 minutes post-instillation, representing the highest IOP elevation recorded during the observation period. Thereafter, IOP gradually reduced, returning towards baseline levels at 60 and 90 minutes (17.0 ± 2.83 mmHg and 17.0 ± 2.65 mmHg, respectively) and reaching 16.6 ± 1.95 mmHg at 120 minutes.

Table 1: IOP Measurements (mmHg) of Five Rabbits Before and After Instillation of Cyclopentolate 1%w/v

Rabbit	IOP (in mmHg)						
	Baseline	5min	10min	30min	60min	90min	120min
1	14	23	23	23	12	18	19
2	16	19	19	21	18	14	16
3	18	21	21	23	18	16	16
4	18	18	21	21	19	21	18
5	18	21	21	21	18	16	14
Mean	16.8	20.4	21	21.8	17	17	16.6

Table 2 reveals the mean IOP values with the corresponding standard deviations at each time interval. There was a consistent increase in IOP from baseline up to 30 minutes after the instillation of drug, showing the pharmacological effect of cyclopentolate. Statistical analysis revealed a significant increase in IOP at 5, 10, and 30 minutes post-instillation ($p = 0.009$, $p = 0.003$, and $p = 0.001$, respectively). No statistically significant IOP elevation was detected beyond 30 minutes, indicating a return toward physiological baseline values during the latter phase of the observation period.

Table 2: Comparison of Mean Baseline IOP with Mean IOP Across Time Intervals After Instillation of Cyclopentolate 1%w/v

	Baseline	5 minutes	10 minutes	30 minutes	60 minutes	90 minutes	120 minutes
Mean	16.8	20.4	21	21.8	17	17	16.6
N	5	5	5	5	5	5	5
Std. Deviation	1.789	1.949	1.414	1.095	2.828	2.646	1.949

Effect of Tropicamide on IOP

Table 3 shows the IOP readings for five rabbits before and after the instillation of tropicamide 1% in the right eye. Baseline IOP ranged from 14 to 19 mmHg, with a group mean of 16.8 ± 2.17 mmHg. After the instillation, IOP increased to 18.0 ± 1.22 mmHg at 5 minutes and reached its peak value of 20.4 ± 1.95 mmHg at 10 minutes. A significant increase in IOP was the observed at 30 minutes, however IOP subsequently reduced and returned to near-baseline values of 16.8 ± 1.10 mmHg at 90 minutes and 17.0 ± 2.00 mmHg at 120 minutes, indicating a relatively transient ocular hypertensive effect compared to cyclopentolate

Table 3: IOP Measurements (mmHg) of Five Rabbits Before and After Instillation of Tropicamide 1%

Rabbit	IOP (in mmHg)						
	0min	5min	10min	30min	60min	90min	120min
1	16	19	19	18	18	18	18
2	19	18	18	18	18	18	18
3	14	18	21	18	18	16	14
4	19	19	21	18	18	16	19
5	16	16	23	18	16	16	16
Mean	16.8	18	20.4	18	17.6	16.8	17

Table 4 shows the descriptive summary of mean IOP values across time points for the right eye. There was a sudden rise in IOP at 10 minutes after the instillation of tropicamide followed by a gradual return toward baseline, in contrast to the more sustained elevation observed with cyclopentolate. Statistical analysis confirmed a significant IOP elevation exclusively at the 10-minute time point ($p = 0.001$). No statistically significant differences from baseline were detected at any other time interval, demonstrating that tropicamide elicits a shorter-acting effect on change in IOP.

Table 4: Comparison of Mean Baseline IOP with Mean IOP Across Time Intervals After Instillation of Tropicamide 1%w/v

	Baseline	5 minutes	10 minutes	30 minutes	60 minutes	90 minutes	120 minutes
Mean	16.8	18	20.4	18	17.6	16.8	17
N	5	5	5	5	5	5	5
Std. Deviation	2.168	1.225	1.949	0.000	0.894	1.095	2.000

Comparative effect of Cyclopentolate and Tropicamide

Table 5 and Figure 1 reveals two mydriatic agents showed distinctly different temporal IOP profiles. Cyclopentolate induced a more pronounced and sustained elevation in IOP, with statistically significant increases observed at different time interval up to 30 minutes post-instillation ($p = 0.009$ at 5 min, $p = 0.003$ at 10 min, $p = 0.001$ at 30 min) with the peak mean IOP reached 21.8 mmHg representing approximately 29.8% increase above the baseline. While tropicamide produced a shorter and comparatively moderate IOP elevation, with statistically significant changes occurred exclusively at 10 minutes ($p = 0.001$) with Peak mean IOP of 20.4 mmHg representing approximately 21.4% above baseline. Beyond the 10-minute mark, IOP progressively declined without any further significant deviation from baseline values.

Table 5. Comparison of Mean Baseline IOP with Mean IOP Across Time Intervals After Instillation of Tropicamide 1% and Cyclopentolate 1%

Mydriatic agents		Baseline	5 min	10 min	30 min	60 min	90min	120 min
Cyclopentolate	Mean	16.8	20.4	21	21.8	17	17	16.6
	N	5	5	5	5	5	5	5
	Std. Deviation	1.789	1.949	1.414	1.095	2.828	2.646	1.949
Tropicamide	Mean	16.8	18	20.4	18	17.6	16.8	17
	N	5	5	5	5	5	5	5
	Std. Deviation	2.168	1.225	1.949	0	0.894	1.095	2

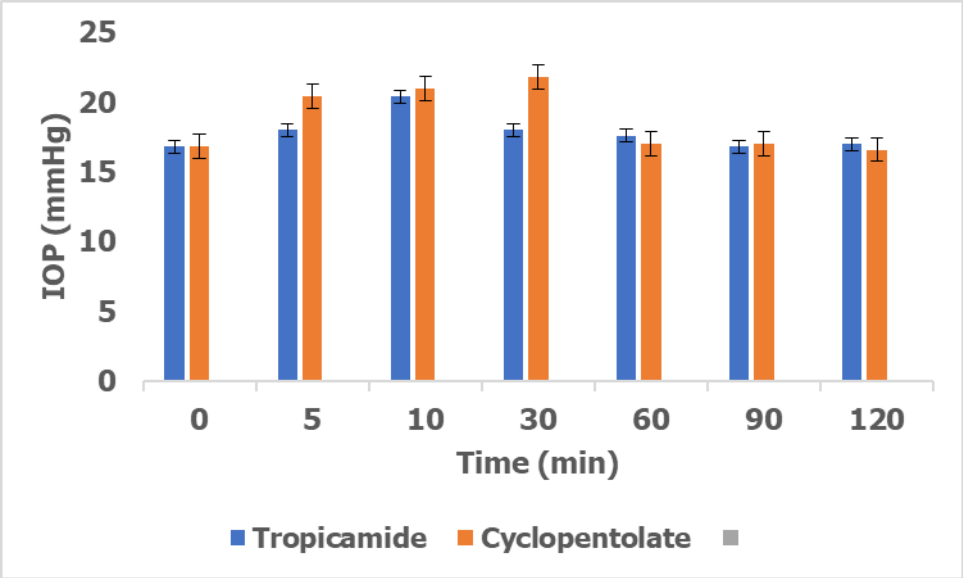

Figure 1: Mean IOP Measurement from the baseline through Time interval after the instillation of both Cyclopentolate and Tropicamide.

DISCUSSION

Cyclopentolate is a fast-acting antimuscarinic drug used in ophthalmology to induce mydriasis (pupil dilation) and cycloplegia (paralysis of the ciliary muscle). It is primarily used in pediatric patients for accurate refraction and in adults when accommodation needs to be temporarily paralyzed [13]. Tropicamide, is a synthetic analog of tropic acid and is known as a safe agent for cycloplegic refraction. It characterized by a rapid onset and the cycloplegia effect appears 20 to 30 min after administration. Its recovery appears 6 hours later. Ocular side effects include stinging sensation in the eye, corneal irritation, and increase in intraocular pressure [7].

A total of 10 right eyes of healthy adult albino rabbits were used in tis research. 50% was used to measure the effect of cyclopentolate on IOP and the remaining 50% was used to measure the effect of tropicamide on IOP. This study investigated the comparative effect of cyclopentolate and tropicamide on intraocular pressure (IOP) in albino rabbits over a 120-minute period post-instillation.

Both drugs showed measurable, time-dependent changes in IOP, with variations between eyes and across time intervals. These findings align closely with a recent clinical study by Adediji et al, [14] that suggests that both cyclopentolate and tropicamide induce time-dependent changes.

Following the administration of cyclopentolate, the eyes exhibited a statistically significant elevation in IOP within the first 30 minutes. The most pronounced increase was observed at 30 minutes post-instillation of the eye drop (mean IOP = 21.8 mmHg). The increase obtained was statistically significant ($p < 0.05$), which confirmed a transient hypertensive effect. However, it was observed that IOP gradually returned toward baseline levels after 90 and 120 minutes post instillation of cyclopentolate, suggesting a relatively short-lived pharmacodynamic impact. These findings agreed with a recent study by Ibrahim et al, [15], who found that IOP was significantly increased starting from 30 minutes till 60 minutes post-instillation of cyclopentolate 1% in healthy human subjects. However, for tropicamide, a similar pattern was observed, though the magnitude of IOP elevation was less marked with a peak mean IOP of 20.4 mmHg at 10 minutes which was statistical significance ($p = 0.001$), afterward IOP values declined steadily, returning close to baseline.

In comparing both agents, cyclopentolate had a greater and more prolonged elevation in IOP than tropicamide. Tropicamide's IOP spike was more transient and less substantial, although both agents peaked early post-instillation (between 10 to 30 minutes). These findings show that cyclopentolate tends to increase IOP more than tropicamide, which appears safer, particularly for patients with open-angle glaucoma [11]. It also supports previous reports suggesting that anticholinergic agents can induce short-term IOP elevations due to angle-closure mechanisms or increased aqueous humor resistance.

CONCLUSION

Cyclopentolate and tropicamide, as revealed in this study tend to induce transient increases in intraocular pressure in healthy albino rabbits, with cyclopentolate having a greater and more sustained elevation. The transient difference in peak IOP elevation which was 30 minutes for cyclopentolate against 10 minutes for tropicamide post instillation along with the broader time interval of significant IOP rise associated with cyclopentolate, underscores the clinical relevance of agent selection, following the use of mydriatics particularly in patients with elevated baseline IOP, glaucoma, or other risk factors predisposing them to IOP-related complications.

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AUTHORS' CONTRIBUTION
OMO – Conceptualization, Methodology, Resources, Supervision, Data curation, Formal analysis, Writing, review and editing; AEI – Data curation, Formal analysis and editing; CCN – Data curation, Formal analysis, review and editing; ML - Data curation, Formal analysis, review and editing.

CONFLICT OF INTEREST
No conflicts of interest were reported by the authors in connection with this work.

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