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Original Research Article

To Determine the Fastest Way of Achieving Tropicamide-Induced Mydriasis

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Conflict of interest: Nil

Abstract

Background: Rapid pupillary dilation is essential for efficient ophthalmic examinations and interventions. Tropicamide is widely used for mydriasis, but the optimal method to achieve the fastest dilation remains unclear.

Objective: To determine the fastest way of achieving tropicamide-induced mydriasis using different instillation protocols and adjuvents.

Methods: A prospective study was conducted on 200 eyes at Mata Gujri Memorial Medical College and L.S.K. Hospital, Kishanganj, Bihar, over 18 months. Patients were divided into 5 groups:

- **Control Group (Group E):** Single drop of tropicamide 0.8% instilled
- **Group A:** Single drop of paracaine 0.5% instilled 5 minutes prior to a single drop of tropicamide 0.8%
- **Group B:** Two drops of tropicamide 0.8% instilled 5 minutes apart
- **Group C:** Single drop of tropicamide 0.8% instilled, followed by eyelid closure for 5 minutes
- **Group D:** Single drop of tropicamide 0.8% instilled, followed by lacrimal sac occlusion for 5 minutes

Time to achieve adequate mydriasis (≥6 mm pupil diameter) was recorded.

Results: Rate of Mydriasis: Group D > Group C > Group B > Group A > Control.

Conclusion: Group D (lacrimal sac occlusion) achieved the fastest and maximum mydriasis due to prolonged ocular surface contact and reduced nasolacrimal drainage.

Keywords: Tropicamide, Mydriasis, Paracaine, Lacrimal Sac Occlusion, Pupillary Dilation.

Introduction

Mydriasis, the pharmacological dilation of the pupil, is essential for comprehensive ophthalmic examinations, including fundoscopy, cataract assessment and retinal imaging. Tropicamide, a synthetic anticholinergic agent, is commonly used to induce mydriasis because of its relatively rapid onset and short duration of action compared to other mydriatic agents like atropine or cyclopentolate [1,2].

Tropicamide works by blocking the muscarinic receptors in the iris sphincter muscle, leading to pupil dilation and cycloplegia, which facilitates detailed posterior segment evaluation [3]. Despite its widespread use, the time taken to achieve adequate mydriasis with tropicamide can vary significantly depending on factors such as drug concentration, mode and frequency of instillation, combination with other agents, and individual patient characteristics like iris pigmentation and age.

Various protocols have been studied to optimize the speed and degree of mydriasis, including using higher concentrations of tropicamide, combination with phenylephrine, and different administration techniques (e.g., single vs multiple drops, punctal occlusion). Rapid achievement of mydriasis is crucial in clinical settings to improve patient throughput, reduce discomfort caused by prolonged

drug instillation, and allow timely diagnosis and treatment of ocular conditions. Therefore, it is important to identify the fastest and most effective method of inducing tropicamide mydriasis to optimize ophthalmic care.

Materials and Methods

Study Design: Prospective, Randomized Comparative Clinical Study

Study Setting: Ophthalmology outpatient department of Mata Gujri Memorial Medical College and L.S.K. Hospital, Kishanganj, Bihar

Study Population: Patients requiring dilated eye examination

Study Duration: 18 Months

Sample Size: A sample size of 200 eyes was taken

Formula for calculating Sample Size:

$\mathbf{n = z^2pq/L^2}$

n = Minimum Sample Size

z = Normal Standard Deviation set at 1.96 which corresponds to the 95%

Confidence Level.

p = Proportion of people with disease in the target population.

q = Proportion of people without disease in the target population.

L = Allowable Error (Taken as 5%)

Inclusion Criteria

- Age ≥18 years
- Normal iris architecture
- Normal pupillary reaction
- Giving informed consent to participate in the study

Exclusion Criteria

- History of angle-closure glaucoma
- Use of mydriatic drugs in the last 30 days
- Hypersensitivity to study drugs
- Previous intraocular surgery
- Active ocular inflammation or trauma
- Uncooperative patients

Study Groups

Patients were randomly divided into five groups:

- Control Group (Group E): Single drop of tropicamide 0.8% instilled
- **Group A:** Single drop of paracaine 0.5% instilled 5 minutes prior to a single drop of tropicamide 0.8%
- **Group B:** Two drops of tropicamide 0.8% instilled 5 minutes apart
- **Group C:** Single drop of tropicamide 0.8% instilled, followed by eyelid closure for 5 minutes
- **Group D:** Single drop of tropicamide 0.8% instilled, followed by lacrimal sac occlusion for 5 minutes

Methodology

- The study began after getting approval from the Institutional Ethics Committee (IEC) of MGM Medical College and LSK Hospital, Kishanganj.
- Written Informed Consent was taken from all the participants.
- Each eye of the patients was randomly assigned to 1 of the 5 groups
- Baseline pupil diameter was measured using a millimeter scale under standardized illumination.
- Mydriatic drops were instilled and other interventions were carried out according to group allocation.
- Pupil diameter was measured at 5-minute intervals up to 30 minutes.
- Adequate mydriasis was defined as a pupil diameter of ≥6 mm.
- Time taken to achieve adequate mydriasis was noted
- Any adverse effects were noted.

Outcome Measures

- Time taken to achieve adequate mydriasis
- Mean pupil diameter at each time interval

Statistical Analysis: The data collected was entered into an MS Excel Spreadsheet. It was subjected to statistical analysis in MS Excel and SPSS version 19.0. Data was then expressed in frequencies and percentages when qualitative and in mean ±SD when quantitative. Chi-square test was used for comparing the trends for all parameters. A p-value of <0.05 was considered significant.

Results

Table 1: Distribution of Study Participants

Group	Method of Mydriasis	Number of Eyes (n)
Control (E)	Single drop of tropicamide 0.8%	40
Group A	Paracaine + single drop tropicamide	40
Group B	Two drops of tropicamide 5 min apart	40
Group C	Tropicamide + eyelid closure	40
Group D	Tropicamide + lacrimal occlusion	40
Total		**200**

Table 2: Mean Pupil Diameter (mm) at Different Time Intervals

Time (min)	Control	Group A	Group B	Group C	Group D
Baseline	3.1 ± 0.3	3.0 ± 0.4	3.1 ± 0.3	3.0 ± 0.2	3.1 ± 0.3
5	3.6 ± 0.4	4.0 ± 0.3	4.3 ± 0.4	4.4 ± 0.3	4.7 ± 0.4
10	4.3 ± 0.5	4.9 ± 0.4	5.3 ± 0.3	5.5 ± 0.4	5.9 ± 0.3
15	5.1 ± 0.4	5.6 ± 0.3	6.0 ± 0.4	6.2 ± 0.3	6.6 ± 0.4
20	5.6 ± 0.3	6.1 ± 0.4	6.5 ± 0.3	6.7 ± 0.4	7.1 ± 0.3
30	6.0 ± 0.4	6.6 ± 0.3	7.0 ± 0.4	7.2 ± 0.3	7.5 ± 0.4

Table 3: Mean Time to Achieve Adequate Mydriasis (≥6 mm)

Group	Mean Time (minutes)
Control	28.5 ± 3.2
Group A	22.4 ± 2.8
Group B	18.6 ± 2.5
Group C	16.8 ± 2.3
Group D	**14.2 ± 2.1**

Table 4: Comparison of Time to Mydriasis (Statistical Analysis)

Comparison	p-value
Control vs Group A	< 0.05
Control vs Group B	< 0.01
Control vs Group C	< 0.01
Control vs Group D	< 0.001

- The control group (single drop of tropicamide) had the slowest onset of mydriasis.
- Group A (paracaine pretreatment) had faster mydriasis than control due to improved corneal penetration.
- Group B (two drops) had faster mydriasis due to increased drug concentration.
- Group C (eyelid closure) achieved mydriasis faster than Groups A and B by reducing drug loss through blinking.
- Group D (lacrimal sac occlusion) achieved the fastest and maximum mydriasis due to prolonged ocular surface contact and reduced nasolacrimal drainage.
- Differences between control and intervention groups were statistically significant ($p < 0.05$).
- Rate of Mydriasis: Group D > Group C > Group B > Group A > Control

Discussion

Adequate and timely mydriasis is essential for comprehensive ocular examination and diagnostic procedures. Tropicamide is the most commonly used mydriatic agent because of its rapid onset and short duration of action. However, variability in the onset and adequacy of mydriasis is frequently encountered in routine clinical practice. This study evaluated different methods of tropicamide administration and compared them with a control group receiving a single drop of tropicamide.

In the present study, lacrimal sac occlusion following a single drop of tropicamide (Group D) achieved the fastest onset of adequate mydriasis, followed by eyelid closure (Group C), repeated instillation (Group B), paracaine pretreatment (Group A), and finally the control group. The difference between the control and intervention groups was statistically significant.

The superior efficacy of lacrimal sac occlusion observed in this study is consistent with earlier reports. Loewenstein et al. demonstrated that nasolacrimal occlusion enhances drug-induced mydriasis by reducing drainage and increasing ocular contact time of topical medications [4]. By preventing rapid loss of the drug through the nasolacrimal system, a greater amount of tropicamide remains available for corneal and conjunctival absorption, resulting in faster and more pronounced pupillary dilation.

Similarly, eyelid closure after instillation of tropicamide (Group C) resulted in significantly faster mydriasis compared to the control group. Kaila et al. showed that eyelid closure reduces systemic absorption of topical ophthalmic drugs by decreasing nasolacrimal drainage, thereby increasing ocular bioavailability [3]. Lam and Chew also reported improved efficacy of topical mydriatics with eyelid closure, supporting the findings of the present study [6]. Eyelid closure is a simple, non-invasive maneuver that can be easily adopted in routine clinical practice.

Repeated instillation of tropicamide (Group B) also resulted in faster mydriasis compared to a single drop. Siderov et al. demonstrated that multiple doses of tropicamide produce greater and faster mydriasis than a single instillation, particularly in individuals with darker irides, due to increased drug availability overcoming pigment binding [2]. However, repeated dosing increases total drug exposure and may not always be necessary when simpler techniques such as lacrimal occlusion or

eyelid closure can achieve comparable or superior results.

Pretreatment with topical anesthetic paracaine (Group A) showed a modest improvement over the control group but was less effective than other intervention groups. Siderov and Bloom reported that prior instillation of proparacaine enhanced tropicamide-induced mydriasis, though the clinical significance of this effect was limited and varied with iris pigmentation[1]. The proposed mechanism is increased corneal permeability and reduced reflex tearing, leading to improved drug penetration. The findings of the present study are in agreement with these observations, suggesting that while topical anesthetic pretreatment may aid mydriasis, its benefit is relatively limited.

Combination mydriatic regimens using tropicamide and phenylephrine have been shown to produce faster and larger pupil dilation than tropicamide alone[5]. However, the addition of adrenergic agents increases the risk of systemic side effects, particularly in elderly patients and those with cardiovascular disease [9]. The present study demonstrates that non-pharmacological measures such as lacrimal occlusion and eyelid closure can significantly enhance tropicamide-induced mydriasis without increasing drug dosage or systemic risk.

From a clinical perspective, the findings of this study have important implications. Teaching patients to perform lacrimal sac occlusion or maintain eyelid closure after instillation of tropicamide can significantly reduce waiting time in busy outpatient departments. These methods are cost-effective, safe, and easily reproducible, making them particularly useful in high-volume and resource-limited settings.

The limitations of this study include a moderate sample size and lack of subgroup analysis based on iris color and age, factors known to influence mydriatic response [2]. Additionally, pupil measurements were performed under standardized room illumination but may still be subject to observer variability.

Conclusion

Among all methods studied, lacrimal sac occlusion following a single drop of tropicamide was the fastest and most effective way of achieving adequate mydriasis. This technique is simple, cost-effective, and easily applicable in routine clinical practice.

Clinical Significance

Practical workflow: In a busy OPD, teaching patients to perform lacrimal occlusion for 30–60 seconds (or for the 5 minutes used in this study) or to keep the eye closed for 1–5 minutes immediately after tropicamide instillation can significantly shorten waiting times and reduce need for additional drops. These are easy-to-teach, low-cost maneuvers with minimal training.

Safety considerations: Occlusion and eyelid closure reduce systemic absorption and may decrease systemic side effects compared with repeated dosing or combination adrenergic agents. Therefore, especially in elderly or cardiovascularly compromised patients, these techniques could be safer alternatives to adding phenylephrine or repeating doses. Kaila et al. showed reduced systemic absorption with occlusion/closure in topical medication studies, supporting this benefit.

Resource-limited settings: For practices or screening camps where phenylephrine may be unavailable or contraindicated, occlusion/closure provide a pragmatic method to speed mydriasis without changing drug regimens.

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