

Studying the Effect of Tropicamide Various Concentrations on Routine Dilation of the Pupil

KEYVAN SHIRZADI¹, ASGARI REZANEJAD AMIRDEHI¹,
ALI MAKATEB¹, KOUROSH SHAHRAKI² and KEIVAN KHOSRAVIFARD^{1*}

¹Department of Ophthalmology, AJA University of Medical Sciences, Tehran, Iran.

²Department of Ophthalmology, Alzahra Eye Hospital, Zahedan University of Medical Sciences, Zahedan, Iran.

*Corresponding author E-mail : khosravi.keivan@gmail.com

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ABSTRACT

Tropicamide is frequently use to dilate the pupil and paralyze the Ciliary body muscle in treatment of ocular disease and diagnosis tests. Since few studies have examined the effect of various concentration of this eye drop on dilation of the pupil, this study designed to investigate concentration effect of tropicamide on mydriasis. In this study, 25 patients referring to the ophthalmology clinic of the Besat Hospital, Tehran, Iran., received different doses of tropicamide (0.5% for right and 1.0% for left eye) to study their pupil's dilation. Photography was performed in 5 steps, before pouring eye drop, 5, 20 and 60 minutes after pouring the eye drop by Zeiss FF 450 camera. Pupil diameter was measured by VISUPAC software and SPSS ver. 14 was used for statistical analysis. The average of pupil diameter measured at 5, 20 and 60 minutes after pouring the eye drop in both groups (0.5 and 1% tropicamide consumers) were adequate for eye tests and pupil diameter differences measured at any of the steps were not significant between the two groups. A subtle increase in pupil diameter was observed by using a low dose of tropicamide in 20 and 60 minutes after pouring eye drop which was not statistically significant. The results of this study showed that using a lower dose of tropicamide provide satisfactory results and thus it is recommended to use low dose of this drug to prevent the possible and unknown side effects.

Key words: Tropicamide, Mydriasis, Pupil diameter, various concentration.

INTRODUCTION

Mydriasis is the dilation of the pupil, usually defined as when having a non-physiological cause, but sometimes defined as potentially being a physiological pupillary response. Non-physiological causes of mydriasis include disease, trauma, or the use of drugs¹

There are two types of muscle that control the size of the iris: the iris sphincter, composed of circularly arranged muscle fibers, and the iris dilator, composed of radially arranged muscle fibers. The sphincter is innervated by the parasympathetic

nervous system; the dilator by the sympathetic nervous system. Sympathetic stimulation of the adrenergic receptors causes the contraction of the radial muscle and subsequent dilation of the pupil. Conversely, parasympathetic stimulation causes contraction of the circular muscle and constriction of the pupil²

The mechanism of mydriasis depends on the agent being used. It usually involves either a disruption of the parasympathetic nerve supply to the eye (which normally constricts the pupil) or overactivity of the sympathetic nervous system (SNS)^{3, 4}

Pupil dilation will disrupt in some diseases, such as uveitis, diabetes, high blood pressure, heart disease, eye surgery, eye trauma, hypothyroidism and hyperthyroidism^{4, 5}

Drugs which used in the testing and treatment of eye diseases that lead to dilation of the pupil or mydriasis are cholinergic antagonists. These drugs are also called anticholinergic. An anticholinergic agent is a substance that blocks the neurotransmitter acetylcholine in the central and the peripheral nervous system. Anticholinergics inhibit parasympathetic nerve impulses by selectively blocking the binding of the neurotransmitter acetylcholine to its receptor in nerve cells. The nerve fibers of the parasympathetic system are responsible for the involuntary movement of smooth muscles present in the gastrointestinal tract, urinary tract, lungs, etc⁶ Anticholinergics are divided into three categories in accordance with their specific targets in the central and/or peripheral nervous system: antimuscarinic agents, ganglionic blockers, and neuromuscular blockers⁷

The most important function of this drugs is mydriasis which is done by paralysis of the sphincter muscle with cycloplegia. The most frequent use of these drugs can be noted funduscopy, cycloplegic refraction and anterior uveitis. Tropicamide, cyclopentolate, atropine, homatropine and scopolamine can be noted as some of these drugs^{8, 9}

Tropicamide is an antimuscarinic drug that produces short acting mydriasis and cycloplegia when applied as eye drops. It is used to allow better examination of the lens, vitreous humor, and retina. Due to its relatively short duration of effect (4–8 hours), it is typically used during eye examinations such as the dilated fundus examination, but it may also be used before or after eye surgery. Cycloplegic drops are often also used to treat anterior uveitis, decreasing risk of posterior synechiae and decreasing inflammation in the anterior chamber of the eye¹⁰ Tropicamide is occasionally administered in combination with p-hydroxyamphetamine, which is a sympathomimetic. The use of the sympathomimetic drug causes the iris dilator muscle to be directly stimulated, causing

increased dilation¹¹ The maximum time needs for dilate the pupil is 20-40 minutes and also 20-35 minutes is necessary to paralyze the ciliary body muscle. Pupils will be dilated for 6-7 hours and ciliary body muscle paralysis will continued for 1-6 hours¹²

As there is few studies to investigate the efficacy of various doses tropicamide, this study was performed with to investigate the effect of different concentrations of this drug on a routine pupil dilation.

METHODS

This clinical intervention study was contained 25 participants with 50 normal eyes, in eye clinic of the Besat hospital. Selection of participants were based on initial filled out demographic questionnaire and screened by ophthalmologic examination in 1 month. Participants with affective disorders on pupil dilation were excluded. The exclusion criteria were contain uveitis, diabetes, high blood pressure, heart disease, eye surgery, eye trauma, hypothyroidism and hyperthyroidism.

To investigate the effect of different concentrations of tropicamide in this study, 50 eyes of 25 participants were divided into two groups: the right eye and the left eye. The first group received a drop of 0.5% tropicamide in their right eye and the second ones received a drop of 1.0% tropicamide in their left eye. Photos of pupils were taken by Zeiss FF 450 camera before pouring a drop, and at 5, 20 and 60 minutes after that. VISUPAC software was used to calculate the size of the pupils. The diameter of the pupils were reported based on the average of maximum horizontal and vertical diameter of pupils. Less than 6 mm of pupil diameter was considered as ineffective dilation.

All statistical analysis were done by SPSS ver. 14. Normal distribution of quantitative variables was evaluated using the Kolmogorov-Smirnov test (KS) and P-value<0.05 was considered as a significant change. According to the type of variable distribution, parametric (one sample t-test) and non-parametric (independent t-test) tests were used to compare two groups.

RESULTS

In this study, the effect of different concentrations of tropicamide on 50 eyes of 25 participants were examined. Results showed that the mean age of participants was 46.4 ± 11.8 years. Maximum and minimum ages were 67 and 28 years old, respectively.

The mean diameter of the pupil before using tropicamide on the right and left eyes were 3.5 ± 0.78 and 3.48 ± 0.69 mm, respectively. Statistical analysis by independent t-test did not show any significant differences between right and left pupil diameter (P -value=0.569). It can be concluded that there was no differences between these groups.

A drop of 0.5% tropicamide was poured in participant's right eye a drop of 1.0% tropicamide in their left one. The average of pupil diameter was measured after 5, 20 and 60 minutes. Differences in pupil diameter between 0.5 and 1% tropicamide eye recipient was evaluated statistically. The results can be seen in table 1.

DISCUSSION

Topical cycloplegic drugs have been used to paralyze from the second half of the nineteenth century due to determine the refractive state. These drugs are typically used for determination of eye refraction on children, people with strabismus, and also those who not cooperate with ophthalmologists during the examination (such as mentally retarded persons)¹³

Tropicamide is used to dilate the pupil and paralyze the ciliary body muscle in ophthalmologic diagnosis methods. Tropicamide is an anticholinergic agent that inhibits muscarinic

receptors in the radial muscles of the iris and ciliary body muscle that cause pupil dilation and the ciliary body muscle paralysis, respectively. One of the usage of this drug is refractive accurate determination which is necessary before the refractive surgeries¹⁴

The radius of the cornea curvature which is associated with refractive power will change on specific conditions. These changes has been proven in some situations such as using contact lenses (especially hard varieties), corneal transplants (because of the quality of suture and the amount of stretching) and refractive surgery (radial keratectomy, photorefractive keratectomy and LASIK)^{5, 12, 15} There is not sufficient studies in cases which the change of corneal curvature and its power is not measurable with usual equipment (keratometer). Although corneal curvature and its power have been measured with various tools such as keratometer, but in recent years using computers to analysis of data obtained from topographic keratoscopy devices (video keratoscopy) have been made a revolution in the measurement accuracy. By this revolution, it is possible to identify factors that can cause minor changes in characteristics of corneal topography. For this reason, the assessment of the effects of these drugs on the change of corneal curvature and its power have an utmost importance particularly in the planning and calculation of refractive surgeries. Studies about local cycloplegic drugs and their effects in changing corneal curvature and its power had various results and interpretations¹⁶⁻¹⁹

In this study, administration of tropicamide drops in both doses of 0.5 and 1% increased pupil diameter about 0.95 mm from baseline in the first 5 minutes, and 20 minutes after administration the change was about 2.1 mm for 0.5% and 2 mm for

Table 1: The average of pupil diameter

| | Right eye (0.5% tropicamide) | Left eye (1.0% tropicamide) | P-value* |
|------------------|------------------------------|-----------------------------|----------|
| After 5 minutes | 4.45 ± 0.935 | 4.45 ± 0.930 | 0.923 |
| After 20 minutes | 6.51 ± 0.759 | 6.50 ± 0.696 | 0.931 |
| After 60 minutes | 6.88 ± 0.646 | 6.93 ± 0.627 | 0.11 |

*Calculated by 2 independent t-test

1%. Then, after an hour, the increase in pupil diameter was 4.9 mm for a 0.5% tropicamide and it was approximately 3.46 mm for 1%.

The reason of different responses of tropicamide 1% over time is not entirely clear. Probably the main reason is plateau phenomenon which reduce the impact of drug by acting on some other receptors instead of main receptors due to being saturated. By the way, proving this hypothesis requires further studies.

Manny *et al.*¹⁵ conducted a study to investigate the effect of tropicamide 1% on children with myopia. Their results showed that in children with myopia, the effect of tropicamide have been different in each eyes. Because in this study different doses of tropicamide were used for each different eye, it was not possible to compare our results with Manny studies.

Chew *et al.* (2005) examined the effect of several mydriatic drugs for screening of diabetes in premature infants who have had dark iris. In this study the effect of cyclopentolate 1%, phenylephrine 2.5%, tropicamide 1% and combination of these drugs were evaluated. All these mydriatic regimes caused enough mydriasis after 45 minutes. They illustrated all combination of mydriatic drugs used in their study can cause hypertension and food intolerance²⁰

CONCLUSION

The results of this study show that using higher doses of tropicamide cannot increase the pupil diameter and it is probably because of plateau phenomenon due to pharmacology of this drug. Finally, this study proves that using a lower dose of tropicamide (0.5%) leads to satisfactory results and therefore to prevent possible and unknown side effects, the low dosage of this drug is recommended.

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