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Assessment of non-invasive tear break-up time and tear meniscus height after instillation of three different formulations of anesthetic eye drops by Oculus Keratograph 5M

Avaliação do tempo de ruptura lacrimal não invasivo e da altura do menisco lacrimal após a instilação de três diferentes formulações de colírio anestésico por Oculus Keratograph 5M

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Abstract

Purpose: *To assess the non-invasive tear break-up time (NITBUT) and tear meniscus height (TMH) after instilling the three different types of anesthetic eye drops by Oculus Keratograph 5M.* ***Methods:*** *In this prospective study, 85 healthy subjects (85 eyes) were randomly divided into three groups. The groups were randomly received lidocaine hydrochloride 2%, proparacaine hydrochloride 0.5%, and tetracaine hydrochloride 0.5%. The qualitative and quantitative parameters of tear film were assessed using NITBUT and TMH, respectively. In all groups, the quantity of tear film using TMH was measured in the right eye of subjects, while the quality of tear film using NITBUT was assessed in the left eye. The analysis of variance (ANOVA) was used to compare the difference between before and after the intervention. A P-value < 0.05 was considered significant.* ***Results:*** *Differences for TMH and NITBUT between before and after applying lidocaine hydrochloride 2% were not statistically significant (P > 0.05). The mean values of NITBUT and TMH after the instillation of proparacaine hydrochloride 0.5% showed a significant decrease than before the intervention (P < 0.05). Also, after the use of tetracaine hydrochloride 0.5%, the mean value of NITBUT was significantly increased (P < 0.05), but the mean value of TMH was significantly decreased than before the intervention (P < 0.05).* ***Conclusion:*** *Our study showed that lidocaine hydrochloride 2% as an anesthetic eye drops can be an appropriate choice for eye examinations due to a lack of significant effect on the quantity and quality of tear film.*

Keywords: *Lidocaine; Proparacaine; Tetracaine; Anesthetics.*

Resumo

Objetivo: Avaliar o tempo de ruptura lacrimal não invasivo (NITBUT) e a altura do menisco lacrimal (TMH) após instilar os três tipos diferentes de colírio anestésico pelo Oculus Keratograph 5M. **Métodos:** Neste estudo prospectivo, 85 indivíduos saudáveis (85 olhos) foram divididos aleatoriamente em três grupos. Os grupos receberam aleatoriamente cloridrato de lidocaína a 2%, cloridrato de proparacaína a 0.5% e cloridrato de tetracaína a 0.5%. Os parâmetros qualitativos e quantitativos do filme lacrimal foram avaliados utilizando NITBUT e TMH, respectivamente. Em todos os grupos, a quantidade de filme lacrimal utilizando TMH foi medida no olho direito dos sujeitos, enquanto a qualidade do filme lacrimal usando NITBUT foi avaliada no olho esquerdo. A análise de variância (ANOVA) foi utilizada para comparar a diferença entre antes e depois da intervenção. Um valor de P < 0.05 foi considerado significativo. **Resultados:** Diferenças para TMH e NITBUT entre antes e depois da aplicação de cloridrato de lidocaína a 2% não foram estatisticamente significantes (P > 0.05). Os valores médios de NITBUT e TMH após a instilação de cloridrato de proparacaína a 0.5% mostraram uma diminuição significativa do que antes da intervenção (P < 0.05). Além disso, após o uso de cloridrato de tetracaína a 0.5%, o valor médio de NITBUT foi significativamente aumentado (P < 0.05), mas o valor médio de TMH foi significativamente menor do que antes da intervenção (P < 0.05). **Conclusão:** Nosso estudo mostrou que o cloridrato de lidocaína a 2% como colírio anestésico pode ser uma escolha apropriada para exames oftalmológicos devido à falta de efeito significativo sobre a quantidade e a qualidade do filme lacrimal.

Descritores: Lidocaína; Proparacaína; Tetracaína; Anestésicos

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Introduction

Anesthetic acts by temporarily blocking the sensation of pain during diagnostic and therapeutic procedures, this is by inhibiting the influx of sodium ions into the nerve cytoplasm.[1,2] It binds to the specific receptor site within the sodium channels and blocks the sodium ion movements through this pore. This property blocks the pain sensation locally hence the name local anesthetic.[1-4] Topical anesthetics play an important role in the practice of ophthalmology and optometry, both for procedures in the office and in the operating room. Topical ophthalmic anesthetic preparations are typically acidic, which contributes to the stinging sensation when first applied. The vast majority of ophthalmic procedures are performed using topical anesthesia.[4,5] The use of topical anesthetic agents for ocular examinations has been reviewed in several studies.[1,5,6] Analgesia of the ocular surface is commonly achieved with topical application of 0.5% proparacaine, or 0.5% and 1% tetracaine ophthalmic solutions, which have a rapid onset of action associated with a brief maximal anesthetic effect, ranging from 5 to 15 minutes.[4-6] Lidocaine is an established topical anesthetic which blocks the sensory nerve endings of the cornea. Lidocaine is prototype of amide-linked agents, which are metabolized by liver and are longer acting.[6-8] The corneal changes are known to result from a direct toxicity of the topical anesthetics to the corneal epithelial cells, and/or a combined effect on blink rate, reflex tearing and stability of the tear film. All these agents have different time of onset and duration of anesthesia.[9-12] Recent advances in new technologies have enabled us to non-invasively evaluate the quantity and quality of the tear film. The Oculus Keratograph 5M (manufactured by Oculus Optikgeraete GmbH, Wetzlar, Germany) is an advanced corneal topographer with a built-in real keratometer and a color camera optimized for external imaging. Tear meniscus height (TMH) and non-invasive tear break-up time (NITBUT) can easily be assessed with both white and infrared light by the K5M.[13,14] The results of this research will enable ocular health practitioners to know the exact effect of anesthetic eye drops on tear production and take necessary precaution on its use. To our knowledge, the NITBUT and TMH changes after applying three different formulations of anesthetic eye drops using the Oculus Keratograph 5M have not been extensively investigated. This study aimed to compare the NITBUT and TMH values prior to and after using lidocaine hydrochloride 2%, proparacaine hydrochloride 0.5% and tetracaine hydrochloride 0.5% by the K5M.

Methods

A total of 90 participants were recruited into the study, 85 healthy subjects (28 subjects in Group A, 29 subjects in Group B, and 28 subjects in Group C) completed the entire protocol. A total of 5 subjects (2 subjects in Group A, 1 subject in Group B, and 2 subjects in Group C) failed to complete the study. The exclusion criteria were as follows: patients with an allergy, infection, or eye surface problems (e.g., pterygium); patients using contact lenses; patients using ophthalmic drugs, such as steroidal or non-steroidal anti-inflammatory, antihistamines, and glaucoma medications during the previous month, or systemically using drugs influencing tear production, such as cortisones, hormones, beta- blockers, antidepressants, and chemotherapy drugs; patients with a history of ophthalmic surgical operations; patients undergoing radiotherapy; and pregnant or breastfeeding patients. For the subjects who met the above criteria, the purpose of the study was explained. If willing, they were asked to sign the informed consent form which was prepared based on the Declaration of Helsinki. The subjects were examined in two visits; one before the use of anesthetic eye drops, and one 15 minutes after the intervention. At first, the examination of the ocular surface and the eyelids was performed with a slit-lamp biomicroscope to rule out any other ocular diseases. Then, the quality and quantity of tear film at baseline examination with use of NITBUT and TMH without any anesthesia were measured in three groups. After 15 minutes, in the Group A of lidocaine 2%, in the Group B of proparacaine 0.5%, and in the Group C of tetracaine 0.5% was used in both eyes of subjects. Then, the values of TMH and NITBUT after applying the three different types of topical anesthetic agents were measured in the three groups. In all groups, the quantity of tear film using TMH was measured in the right eye of subjects, while the quality of tear film using NITBUT was assessed in the left eye. All subjects underwent imaging with the Oculus Keratograph 5M (K5M) equipped with a modified tear film scanning function. In each subject, inferior TMH images were captured and measured perpendicular to the lid margin at the central point relative to the pupil center using an integrated ruler. The TMH was measured twice for each eye using IR images derived from the Oculus TMH tool in millimeters. The TMH test was classified as follows: Good > 0.2 mm, Normal = 0.2 mm, Poor < 0.2 mm. The NITBUT was measured as the time in seconds between the last complete blink and the first perturbation of placid rings projected onto the surface of the cornea, which the device automatically detects. Based on the device IR video, the K5M generates 2 measures for NITBUT: NITBUT-first (time at which the first breakup of tears occurs, is the parameter of interest in this study) and NITBUT-average (average time of all breakup incidents). The value of NITBUT > 10 seconds was considered normal. The measurements were taken in a dimly lit room, where the temperature (20 – 25°C) and humidity (30 – 40%) were controlled. Statistical analysis was performed using SPSS version 18.0 (SPSS Inc., Chicago, IL, USA). To compare changes in the TMH and NITBUT measurements after using the three different formulations of anesthetic eye drops, repeated-measures analysis of variance (ANOVA) was used. A P-value < 0.05 was considered statistically significant.

Results

The mean age of participants in Group A, B, and C was 20.08 ± 3.24 years (range: 17 to 33 years), 21.73 ± 4.21 (17 to 35 years), and 20.67 ± 3.85 (18 to 35 years), respectively. The average values of TMH and NITBUT between before and after applying the three different formulations of topical anesthetic agents are shown in Table 1. There was no significant difference in sex (P = 0.125) or age (P = 0.386) among the three groups. As shown in Table 2, the value of TMH in the group A, before and after the use of lidocaine hydrochloride 2% was 0.24 ± 0.28 mm and 0.22 ± 0.12 mm, respectively, which was not statistically significant difference

(P = 0.61). In the group B, the average value of TMH before the intervention was 0.24 ± 0.76 mm, and after the use of proparacaine hydrochloride 0.5% was 0.19 ± 0.10 mm, which was significantly decreased (P < 0.001). The mean of TMH after the use of tetracaine hydrochloride 0.5% to those before the intervention in the group C, 0.3 mm decreased that was not statistically significant (P = 0.29). The mean value of NITBUT from baseline to after the intervention in the group A, 1.06 seconds reduced that was not significant (P = 0.07), while the value of NITBUT in the group B, 4.14 seconds decreased that was statistically significant (P < 0.005). The value of NITBUT before and after the instillation of tetracaine hydrochloride 0.5% in the group C was 11.39 ± 3.62 and 14.55 ± 3.9 seconds, respectively, which was significantly increased (P < 0.001).

Table 1
Demographic features of subjects

Feature	Group A (N= 28)	Group B (N= 29)	Group C (N= 28)	P-value
Mean age ±SD	20.08 ± 3.24 (range: 17 to 33 years)	21.73 ± 4.21 (range: 17 to 35 years)	20.67 ± 3.85 (range: 18 to 35 years)	0.386
Male/Female	13/15	16/13	14/14	0.125

Group A: Normal subjects assigned to use of lidocaine eye drops 2%
Group B: Normal subjects assigned to use of proparacaine eye drops 0.5%
Group C: Normal subjects assigned to use of tetracaine eye drops 0.5%
SD: Standard deviation
N: Number of patients

Table 2
Results of the TMH and NITBUT measurements before and after intervention

Test	Group A		Group B		Group C	
	Baseline	After intervention	Baseline	After intervention	Baseline	After intervention
TMH (Millimeters)	0.24 ± 0.28	0.22 ± 0.12	0.24 ± 0.76	0.19 ± 0.10	0.24± 0.19	0.21 ± 0.08
NITBUT (Seconds)	11.35 ± 3.78	10.29 ± 3.50	11.31 ± 3.45	7.17 ± 2.60	11.39 ± 3.62	14.55 ± 3.9

Group A: Normal subjects assigned to use of lidocaine eye drops 2%
Group B: Normal subjects assigned to use of proparacaine eye drops 0.5%
Group C: Normal subjects assigned to use of tetracaine eye drops 0.5%
NITBUT: Non-invasive tear break-up time
TMH: Tear meniscus height

Discussion

Local anesthetics can provide excellent corneal analgesia. When applied in an effective concentration to nerve tissue, local anesthetics reversibly block the conduction of impulses through nerve fibres. The primary action is to prevent impulses conduction.[15,16] However, they will also block motor nerves in higher concentrations than are normally obtained by topical instillation. Unfortunately, prolonged application of local anesthetics is associated with delay of corneal reepithelialization after wounding, altered lacrimation and tear film stability, corneal swelling, and disruption of epithelial cell motility.[15-17] In the current study, the effects of three different formulations of anesthetic eye drops on the quality and quantity of tear film was compared. Our results indicated that the mean value of TMH after the use of proparacaine hydrochloride 0.5% was significantly reduced. The current study is in agreement with Raj's study, [18] who observed a significant decrease in the mean value of TMH after the use of proparacaine hydrochloride 0.5%. In some studies, it has been understood that proparacaine hydrochloride 0.5% inhibits parasympathetic stimulation to the main accessory lacrimal glands and meibomian glands more than tetracaine hydrochloride 0.5% and lidocaine hydrochloride 2%.[16,19-22] Local anesthetic eye drops such as proparacaine hydrochloride 0.5% is associated with epithelial defects and stromal haze. On the other hand, local anesthetics have been shown to disrupt the surface micro villi of epithelial cells, decrease mucous adherence, and shorten tear breakup time.[19-22] In our study, the results for the mean value of NITBUT showed that tetracaine hydrochloride 0.5% has a significant effect in the increase of NITBUT compared with baseline. In a study by George et al. [23] found that the quantity of tear film after the use of proparacaine hydrochloride 0.5% is significantly decreased. Also, in the same study found an increase in the value of NITBUT after applying tetracaine hydrochloride 0.5%. In a number of other studies, increased precorneal tear thinning time with the use of tetracaine hydrochloride 0.5% have also been reported.[24-26] Therefore, the findings of this study and previous studies can be related to the fact that anesthetic eye drops reduce the quality and quantity of tear film.

Conclusion

We concluded that lidocaine anesthetic drops have less effect on the quality and quantity of tear film than proparacaine and tetracaine drops. Therefore, lidocaine eye drops 2% can be clinically suitable for routine eye examinations by ophthalmologists and optometrists.

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