icare 리바운드 압안계로 측정된 안압에 대한 국소마취제의 영향

Effect of Topical Anesthesia on Intraocular Pressure Measured by iCare Rebound Tonometer

정 윤, 이종연, 유정권, 김용연

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Purpose: To investigate whether topical anesthesia affects intraocular pressure (IOP) reading obtained with iCare rebound tonometer (RT).

Methods: A total of eighty eyes of 40 healthy subjects were included. Both eyes were divided into two groups (0.5% proparacaine hydrochloride or 0.5% carboxymethylcellulose sodium). Central cornea thickness (CCT) was obtained with specular microscopy and IOP was measured with RT at baseline. CCT and IOP were measured at 1 minute after instillation of either of the two eye drops.

Results: IOPs measured by RT decreased significantly after instillation of a single drop of 0.5% proparacaine hydrochloride (13.00 to 12.00 mmHg, median value, $p < 0.001$) or, 0.5% carboxymethylcellulose sodium (13.00 to 12.75 mmHg, median value, $p = 0.02$) compared to the pre-instillation IOP readings. The magnitude of IOP reduction seen after instillation of 0.5% proparacaine hydrochloride was significantly greater than CMC group. (1 mmHg vs. 0.25 mmHg, median value, $p < 0.001$). No significant changes in CCT change was observed in both groups.

Conclusions: When instilled prior to rebound tonometry, both 0.5% proparacaine hydrochloride and 0.5% carboxymethylcellulose sodium eye drops decreased IOPs. The 0.5% proparacaine hydrochloride may have a greater IOP-lowering effect than 0.5% carboxymethylcellulose sodium eye drop.

Key words: Intraocular pressure, Anesthesia

Introduction

Recently, iCare[®] rebound tonometer (RT) has been introduced. It is portable and it does not require anesthesia and an experienced examiner. Several investigators have reported its good correlation with Goldmann applanation tonometry (GAT) in healthy subjects and patients with glaucoma.¹⁻⁶ However, a number of studies have demonstrated

that RT tends to slightly overestimate intraocular pressure (IOP) compared with GAT, whereas some reports have presented contrary findings.¹⁻¹³

Some investigators reported that use of topical anesthetics can reduce the IOP measured by noncontact tonometry in adults.^{14,15} However, to date, there has been only one report which investigated the influence of topical anesthesia on IOP readings measured by RT. This study did not find any significant change of IOP after topical anesthesia in children.¹⁶ Therefore, the aims of study was to determine whether topical anesthesia affect IOP measurement by RT in healthy adult subjects.

Materials and Methods

Forty volunteers were recruited from ophthalmology clinic at Gachon University Gil Medical Center. The research

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adhered to the tenets of the Declaration of Helsinki and was approved by our ethics committee. Informed consent was obtained from each participant. Subjects were excluded if they had any serious ocular disease including glaucoma and cornea pathology, and/or previous history of ocular surgery such as refractive surgery and use of contact lenses.

Each subject was assigned to two different eye drops in both eyes: 0.5% carboxymethylcellulose sodium (Refresh plus®, Allergan, Parsippany, NJ, USA) and 0.5% proparacaine hydrochloride eyedrop (Alcaine®, Alcon Lab., Fort Worth, TX, USA). The laterality of the eye for use of each eye drop was alternated between subjects to avoid the effect of instillation sequence on IOP measurement. For example, for the first subject, right eye was set to use 0.5% carboxymethylcellulose sodium eye drop; left eye, 0.5% proparacaine hydrochloride eyedrop. For the second subject, the instilled drugs were changed: Right eye was set to use 0.5% proparacaine hydrochloride eye drop; Left eye, 0.5% carboxymethylcellulose sodium eye drop.

In all subjects, the central cornea thickness (CCT) was measured using noncontact specular microscope (Topcon SP-2000p noncontact specular microscope, Topcon Corp, Tokyo, Japan). Then, IOP were measured using RT and the Goldmann applanation tonometer (GAT; Haag-Streit, Koeniz, Switzerland) in the following order: CCT (CCT1) and IOP by rebound tonometry (RT1) were obtained. After an instillation of each eyedrop in each eye, CCT (CCT2) and IOP by rebound tonometry (RT2) were obtained. Finally, GAT was measured immediately after an instillation of 0.5% proparacaine hydrochloride eye drop. IOP and CCT measurement were obtained by one experienced ophthalmology resident, masked to a subject's data. All measurements were always obtained first in the right eye. CCT was measured three times with a noncontact specular microscope. The mean of three CCT readings calculated. IOP was initially measured three times using iCare rebound tonometer (TA01; Tiolat Oy, Helsinki, Finland). To take IOP measurements, the device is positioned near the patient's eye with the forehead being as a base support, and the tip of the probe is positioned at a distance of approximately 4 to 8mm from the cornea. Individual measurements are dis-

played in mmHg. The mean of six readings was generated automatically as an IOP value. As manufacturer instructions, a mean reading displayed with a static P and no error bars (P) indicates a low SD of 6 measurements. IOP value was recorded as the mean of 2 consecutive measurements which were within 2 mmHg and both low error as indicated on iCare rebound tonometer or the median of three measurements if the first two differed by 3 mmHg. CCT and IOP (RT2) were repeatedly measured in the same manner at 1 minute after instillation of an eye drops. We asked participants to blink normally between the measurements.

Statistics

A pilot study of 10 subjects revealed that mean IOPs before and after paracaine hydrochloride were 13.65 ± 2.94 mmHg and 12.10 ± 3.22 mmHg respectively. A sample size calculation determined that 40 subjects were required with a power of 87%. Kolmogorov-Smirnov test was used for test of normality. Wilcoxon signed rank test was used to evaluate IOP changes induced by instillation of each eye drops. Nonparametric T-test were used to compare IOP including RT1, RT2 and the difference between RT1 and RT2 (Δ RT) between groups. T-test was used for comparison of CCT between two groups and Paired-T Test was used for CCT changes in each group. A *p*-value of <0.05 was considered statistically significant. Statistical analyses were performed using SPSS version 21.0 (SPSS Inc., Chicago, IL, USA).

Results

A total of 80 eyes of 40 subjects were included in this study. Mean age was 28.8 ± 2.51 years old. Twenty women and twenty men were included in this study. Median values of IOPs measured by RT are summarized in Table 1. Median IOP measured by RT before instillation of each eye drop (RT1) did not differ between both groups ($p = 0.808$). IOP (RT2) measured by RT significantly decreased after use of proparacaine hydrochloride compared with RT1 ($p < 0.001$). IOP also significantly decreased after CMC ($p = 0.02$). However, the post-instillation IOP in the proparacaine hydrochloride group (RT2) was significantly lower than that

Table 1. Median intraocular pressure (IOP) measured by iCare rebound tonometer before, and after instillation of two different eye drops

	Proparacaine hydrochloride (n = 40)	CMC (n = 40)	p-value*
RT1 (mmHg)	13.0 (12.0, 14.0)	13.0 (12.0, 14.0)	0.808
RT2 (mmHg)	12.0 (11.5, 12.0)	12.75 (11.63, 13.50)	0.038
RT1-RT2 (mmHg)	1.00 (0.5, 2.0)	0.25 (0.00, 1.00)	<0.001
p-value [†]	<0.001 [†]	0.020 [†]	

Data was presented as median (interquartile range) RT1: IOP measured by iCare rebound tonometer before each eye drop use, RT2: IOP measured by iCare rebound tonometer after each eye drop use, RT1-RT2: difference between RT1 and RT2.

CMC=carboxymethyl cellulose 0.5% (Refresh plus, Allergan, Irvine, CA, USA).

*p-value comparison between proparacaine hydrochloride and CMC using Mann-Whitney U test; [†]p-value: comparison between RT1 and RT2 in each eye drop group using Wilcoxon signed-rank test.

Table 2. Comparisons of intraocular pressure differences between Goldmann applanation tonometer and rebound tonometer before and after two different eye drops

	Proparacaine hydrochloride (n = 40)	CMC (n = 40)	p-value*
GAT (mmHg)	12.0 (11.0, 12.0)	12.0 (11.63, 12.0)	0.211
RT1-GAT (mmHg)	1.0 (1.0, 2.0)	1.0 (0.00, 1.00)	0.007
RT2-GAT (mmHg)	0.0 (0.0, 0.5)	0.5 (0.0, 1.0)	0.011
p-value [†]	<0.001	<0.001	
p-value [‡]	0.006	<0.001	

Data was presented as median (interquartile range). RT1: IOP measured by iCare rebound tonometer before each eye drop use, RT2: IOP measured by iCare rebound tonometer after each eye drop use.

CMC=carboxymethyl cellulose 0.5% (Refresh plus, Allergan, Irvine, CA, USA).

*p-value comparisons between proparacaine hydrochloride and CMC using Mann-Whitney U test; [†]p-value comparison between RT1 and GAT (RT1-GAT) using Wilcoxon signed-rank test; [‡]p-value: comparison between RT2 and GAT (RT2-GAT) using Wilcoxon signed-rank test.

in carboxymethylcellulose sodium group ($p < 0.001$). The IOP difference between RT1 and RT2 (ΔRT) in the proparacaine group was significantly greater than that in the carboxymethylcellulose sodium group ($p < 0.001$).

IOP readings obtained using GAT and RT before and after eye drops are listed in Table 2. RT1 and RT2 were significantly different from GAT-IOP. In addition, the IOP changes between RT1 and GAT, and those between RT2 and GAT were significantly different between proparacaine hydrochloride and carboxymethylcellulose sodium groups. ($p = 0.007$ and, $p = 0.011$, respectively).

The mean pre-instillation CCT1 of the proparacaine group ($520.0 \pm 20.4 \mu\text{m}$) was not different from that of the carboxymethylcellulose sodium group ($518.6 \pm 20.5 \mu\text{m}$, $p = 0.757$). There was no difference in post-instillation CCT2 between both groups. (proparacaine group: $522.6 \pm$

$20.6 \mu\text{m}$ vs. carboxymethylcellulose sodium 521.6 ± 22.8 , $p = 0.840$) No significant CCT change after eye drops was found in both proparacaine and carboxymethylcellulose sodium groups. ($p = 0.158$ and, $p = 0.144$ respectively)

Discussion

This study found that topical eye-drops including topical anesthetics decreased IOP readings taken by RT, and that the RT-IOP after instillation of a topical anesthetic is likely to be closer to the GAT compared with the RT-IOP without topical anesthesia. To our knowledge, this is the first study to investigate the effect of topical anesthesia on RT-IOP reading in adults. Two previous studies reported that topical anesthetics may cause a reduction in IOP values measured by noncontact tonometer.^{14,15} There has been one report

to investigate the influence of topical anesthesia on IOP measured by RT. However, it did not find any significant change of IOP after topical anesthesia in children.¹⁶ The difference may be due to the difference of study population or methodology between the two studies.

Such IOP reduction of RT-IOP value with topical anesthesia could be interpreted in several ways. First, topical anesthesia could reduce patient's discomfort, anxiety and lid squeezing. However, it might not explain this reduction fully since such IOP reduction was also detected in eyes treated with artificial eye drops. Second, this result could not be free from mechanical effects of repetitive IOP measurement. However, it was reported that the effect of repeated measurements with rebound tonometer was not significant.¹⁶ This may be because the contact time and area of RT on cornea surface are relatively shorter and smaller compared to other application tonometers. Therefore, this reduction may be related to change of cornea thickness by eye drops. A previous study indicated that the IOP reduction by topical anesthetics did not appear to be associated with changes in CCT.¹⁷ We did not observe a significant CCT change in topical eye drops, either. Finally, the RT uses an induction-based rebound method where a magnetic probe is bounced off the cornea, and the deceleration of the probe caused by the eye is used to calculate the IOP. Since artificial tear also significantly decreased IOP in this study, this result suggests induction-based method might be affected by eye drops-induced tear film layer thickness change or physical property changes in precorneal tear film such as viscosity or surface tension.^{18,19}

This study has limitations; the present study did not include the control group where no any eye drops was used. However, as aforementioned, it was reported that the effect of repeated measurements with rebound tonometer did not seem to be significant.¹⁶ Moreover, IOP was measured just 1 min after anesthetic instillation. A longer interval between measurements may have yielded the different findings. Alternatively, the mean IOP differences induced by instillation of eye drops may be not clinically relevant. Nevertheless, it appears to be necessary to check whether the patient has used an eye drops before rebound tonometry for precise

measurement of IOP. However, IOPs in the present study were within normal range. Thus, this eye drop-induced IOP change could be different in higher or lower IOP ranges. Finally, although post-instillation RT-IOP was closer to GAT-IOP than the pre-instillation RT-IOP, RT-IOPs and GAT were still significantly different. It may be partially due to the different measurement resolutions between the two tonometry.

In conclusion, this study found that the RT-IOP readings could be decreased when measured after instillation of topical eye drops, and that the decrease was greater with use of 0.5% proparacaine hydrochloride than 0.5% carboxymethylcellulose sodium.

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