diaton®
TONOMETER

INNOVATIVE APPROACH TO IOP MEASUREMENT
TRANSPALPEBRAL SCLERAL TONOMETRY

COLLECTED ARTICLES

edition 7

CE 0535 FDA

Diaton tonometer is a handheld device that measures IOP through the eyelid over the sclera & completely satisfies present-day requirements for diagnostic ophthalmic equipment.

The pen-like tonometer with its innovative method of IOP measuring opens up indisputable clinical opportunities:

No

- contact to the cornea
- risk of infection
- anesthesia drops
- adjustment to pachymetry
- need to take out contacts
- sterilization
- consumables
- discomfort to the patient

Spheres of diaton tonometer application:

- ophthalmology (including children's)
- general medical practice
- optometry
- neurology

Can

- measure IOP even in the presence of viral infections, allergic reactions, dry eye syndrome
- serve as non-invasive day monitoring tool while selecting the adequate hypotensive medical treatment
- measure IOP on patients after corneal surgeries
- measure IOP with contact lenses on
- measure IOP on immobilized patients

Simplicity, quickness and efficiency for doctors and optometrists.
Comfort and safety for patients.

Features	diaton	Goldmann	Shiotz	Air-puff	Tonopen	
No direct contact with the cornea	+					
Independence from the cornea thickness	+					
Portability	+		+		+	
Digital IOP indication	+	+		+	+	
Measurement in sitting position	+	+		+	+	
Measurement in lying position	+		+	+ (some models)	+	
Short-time measurement	+			+	+	
No anesthesia	+			+		
No consumables	+					
After LASIK/PRK measurement	+					

Technical features

Measurement range	5-60 mm Hg
Measurement error	Limit of the admissible measurement error in the range, not more: from 5 to 20 mmHg - ± 2,0 mm Hg; from 20 to 60 mmHg ± 10%
The time of a single measurements, not more	3
Supply voltage, V	3
Number of measurements using one battery set, not less	1500
Service life, years, not less	8
Weight, g, not more	89
Dimensions, mm, not more	174 x 26 x 20

Comparison of Intraocular Pressure before and after Laser In Situ Keratomileusis Refractive Surgery Measured with Perkins Tonometry, Noncontact Tonometry, and Transpalpebral Tonometry

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INTRODUCTION

Intraocular pressure (IOP) measurement is necessary for the screening and diagnosis of glaucoma as well as being an inclusion/exclusion criterion for all types of ocular surgical procedures. LASIK (Laser In Situ Keratomileusis) is the most common surgical technique used to correct low and moderate refractive errors. In the case of myopia, this technique causes an ablation of the corneal tissue that induces changes in the corneal curvature, central corneal thickness (CCT), and corneal rigidity. These changes alter the postsurgical measurement of the IOP (intraocular pressure) measured with Goldmann applanation (GAT) or noncontact air tonometry. There is evidence that the central corneal ablation causes a constant decrease in the tonometry values of around 1.6mmHg (in myopes and hyperopes as well), and myopic patients exhibit an additional reduction of IOP readings due to

the fact that the maximum tissue ablation is in the very center of the cornea, which is 0.029±0.003 mmHg permicrometer of ablated tissue, that is, if we consider a mean corneal tissue remove of 15 microns per diopter, for every diopter we see, and underestimate readings of 0.5mmHg.

Intraocular pressure is a significant risk factor in the diagnosis of glaucoma. Therefore, in patients treated with LASIK, the IOP measurement may be lower and this would lead to later detection of glaucoma.

Glaucoma is distinguished from other optic neuropathies by slow progression over months to years. The prevalence is low before 40 years of age and increases exponentially with age. The association between myopia and glaucoma has been reported by authors from different countries [5–7], who claim that high myopia is a predisposing factor for glaucoma.

Some recent studies on LASIK surgery for myopia correction reported that patients experienced an increase in the intraocular pressure during flap creation that decreased to normal when the suction ended. Furthermore, it has been reported that postsurgical variations in corneal biomechanics lead to complications such as myopia regression. Understanding the biomechanical properties to prevent the onset of these complications has led to a lot of research.

The Perkins applanation tonometer is a portable version of the Goldmann Applanation Tonometer (GAT). GAT is a gold standard method for the measure of IOP; however, the clinician should be careful when interpreting the measurements in 2002; Bhan et al. showed a limitation: GAT underestimates IOP in eyes with significantly thinner corneas and overestimates it with thicker corneas. Its accuracy is influenced by corneal thickness, curvature, rigidity, and corneal hydration. Although it is true that in eyes with increased CCT this measuring technique tends to overestimate IOP, the same seems to be valid for corneas that are flatter or steeper than usual. Several studies have shown that the biomechanical corneal disorder produced by the flap creation for LASIK treatment affects the postsurgical IOP measurement byGoldmann applanation and air tonometry.

The Diaton tonometer measures the intrapalpebral IOP by exerting pressure on the peripheral cornea, outside the ablation, and on the sclerocorneal limbus. The thickness of this peripheral area is not affected

after myopia LASIK surgery. The noncontact air tonometry is an applanation method not requiring anesthesia because it uses a standardized blow of air to flatten the cornea.The flattening is applied to the centre of the cornea and the blow increases its intensity until the flattening of the cornea is obtained; therefore, the higher the intensity, the higher the IOP reading.

The aim of this study was to compare the intraocular pressure measured by three different tonometers before and after LASIK surgery. Two of them perform the measurement in the centre of the cornea and the other one in the corneal periphery.

CONCLUSION

2.1. Patients. Fifty-seven patients with ages ranging from 22 to 53 (average 34.88±8.86) were scheduled for LASIK to treat myopia. One eye per patient was selected at random. More detailed demographic characteristics of the population are shown in Table 1.

Patients were subjected to a complete presurgical ophthalmic examination that includes the IOP tests for this study. These IOP tests were repeated one month after surgery.

Table 1. Demographic characteristics of the participants in the study

Parameter	LASIK	
Number of eyes (patients)	57 (57)	
Age (years) (mean (SD))	34.88 (8.86)	
Age range (years)	[22, 53]	
Gender (male/female)	[27, 30]	
Axial length (mm) (mean (SD))	24.76 (0.88)	
Sphere presurgery (D) (mean (SD))	−2.99 (1.24)	
Cylinder presurgery (D) (mean (SD))	−0.56 (0.40) 91.98 (59.58)	
	Presurgery	Postsurgery
Flat (D) (mean (SD))	43.44 (1.47)	40.92 (1.32)*
Steep (D) (mean (SD))	43.62 (1.42)	41.12 (1.54)*

*** Presurgery versus postsurgery. $p < 0.05$.Student's paired t-test. For details see Section 2**

The study was conducted in compliance with good clinical practice guidelines, informed consent regulations,and the tenets of the Declaration of Helsinki (WMA, 2013). The study was approved by the Balearic Institute of Ophthalmology IRB. All the subjects enrolled in the study were adults older than 18 years who were able to give informed consent and they could leave the study at any time.

2.2. Clinical Measures. Before and after LASIK surgery, spherical equivalent refraction (SER),corneal curvature (K), and central corneal thickness (CCT) and superior corneal thickness (SCT) were obtained. IOP values pre- and postsurgery were measured using three different techniques: Diaton tonometer, Perkins tonometer,and air tonometer.

2.3. Surgery Procedures. Surgery was performed by the same surgeon (Juan Sanchez-Naves) using the Technolas 217 flying spot excimer laser system, version V 312.383 (Bausch & Lomb, Irvine, CA, USA). Laser parameters included the following: wavelength of 193 nm, radiant exposure (Fluence) of 160mJ/cm2,pulse repetition rate of 50Hz,average ablation depth/pulse of 0.25 μm on the cornea,and an ablation zone diameter from 6.5 to 7mm with a transition zone of 0.5 mm. The XP automated microkeratome (Bausch & Lomb, Irvine, CA, USA), a superior-hinged corneal flap (120 or 140 lm head plates), was created. Patients were prescribed topical antibiotic and steroid drops (Tobradex, Alcon, TX, USA) every 6 hr for 5 days. For all eyes, presurgical manifest refraction was selected as the target correction.

2.4. IOP Measurement. Three measurements were taken on each patient and the average of the readings was recorded as the final IOP. During the measurement, subjects were asked to keep the eye open and fixate into the distance behind the examiner. First, three consecutive measurements of IOP with noncontact tonometer, based on air puff (Topcon CT60, Topcon Corporation, Tokyo, Japan), were performed with an approximate time interval of 3 seconds. The IOP measurements were taken by means of a Perkins tonometer after instillation of 1 drop of double anaesthetic Colircusrí which contains tetracaine 0.1% and oxybuprocaine 0.4% (Colircusrí, Alcon Cusrí SA, Barcelona). Finally, ten minutes later,Diaton tonometer

measurements were performed in the sitting position with the patient gazing at a 45° angle, placing the tonometer in contact with the eye lid margin at the superior limbus. The devicewas activated when the signalling mechanism indicated the correct vertical position. There was a 5-minute interval between the Perkins and Diaton measurements. Central and peri pheral corneal thicknesses at 4.5mm superior location from the centre of the cornea (CCT and SCT) were measured, calculated, and provided by videokeratography (Orbscan II, Bausch & Lomb, Rochester, New York,USA).

2.5. Statistical Analysis. Data were analyzed by statistical package SPSS version 17.0 for Windows (SPSS, Inc., Chicago, IL). The values presented are the means ± SD of the values obtained. Normality of distribution was assessed using the Shapiro-Wilks test. The differences between pre- and postsurgery IOPs for each tonometer measurement and the differences between CCT and peripheral corneal thicknesses at superior location were tested for statistical significance using the Student paired t-test. The IOPs between different tonometry devices were compared with Student's t-test for independent samples. Correlations between measurement before and after surgery were evaluated using a Pearson correlation test.

The spherical equivalent refraction (SER) was calculated as the sum of the sphere and half the refractive astigmatism in dioptres (D) obtained after standard subjective refraction. Linear regression analysis was used to quantify the correlation in IOP measurements and various parameters: change in keratometry, change in dioptres of SER, and changes with the age. $p < 0.05$ was considered statistically significant.

RESULTS

The differences of the IOP values between pre- and post-LASIK surgery measured with the Perkins and air tonometers were statistically significant ($p < 0.05$). However, no significant differences were found ($r > 0.05$) in IOP values pre- and post-LASIK surgery measured with Diaton tonometer (Figure 1). Regarding corneal thickness,CCT decreases significantly

after surgery ($p < 0.05$) but no statistical differences were found in SCT ($p = 0.08$). Table 2 shows the mean of IOP with each tonometer and the pre- and postsurgery corneal thicknesses.

Correlations between pre- and postsurgery were found for all tonometers, with $p = 0.001$ and $r = 0.434$ for air pulse tonometer, $p = 0.008$ and $r = 0.355$ for Perkins tonometer, and $p < 0.001$ and $r = 0.637$ for Diaton tonometer. The CCT and SCT values taken pre and post-LASIK surgery showed a positive correlation of $p < 0.001$ and $r = 0.626$ and $p = 0.001$ and $r = 0.542$, respectively.

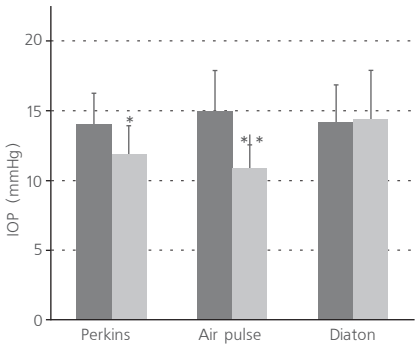

Figure 1: Comparison of the pre- and postsurgery IOP for the Perkins, noncontact, and transpalpebral tonometries ($p < 0.05$ Diaton versus Perkins; **$p < 0.05$ Diaton versus air pulse tonometry; Student's t-test for independent samples).

The IOP values using the air tonometer and the Perkins tonometer were correlated both before surgery with $p = 0.002$ and $r = 0.407$ and after surgery with $p = 0.002$ and $r = 0.408$, although no correlation was found between the IOP values measured with Diaton tonometer and Perkins tonometer before with $p = 0.338$ and $r = 0.132$and after surgery with $p = 0.358$ and $r = 0.124$.

Regarding corneal thickness, CCT values were found to correlate with the IOP values measured using Perkins and air tonometers, both before surgery with $p = 0.035$ and $r = 0.286$, and $p = 0.004$ and $r = 0.373$ and after surgery with $p = 0.017$ and $r = 0.312$, respectively. However, the SCT values for both the pre- and the postsurgery measurements did not correlatewith the IOPvalues from the Diaton tonometer with $p = 0.369$ and $r = 0.124$, and with $p = 0.453$ and $r = 0.167$, respectively.

Finally, the change in diopters for the SER before surgery was correlated with the difference

between the IOP values measured before and after surgery using air tonometer with $p = 0.009$ and $r = -0.343$ and also with the CCT with $p < 0.001$ and $r = -0.660$. However,no correlation was found with Perkins and Diaton tonometer with $p = 0.256$ and $r = -0.156$, and with $p = 0.466$ and $r = -0.102$, respectively.

DISCUSSION

The aim of this study was to evaluate the IOP before and after myopic LASIK surgery taking into account the implication that corneal thickness has on the measurement. The accuracy of intraocular pressure measurement is critical for the glaucoma diagnosis and its follow-up. Low IOP readings after LASIK would result in a delayed diagnosis of glaucoma or recognition of ocular hypertensive patients. Various measurement methods have been used previously for the quantification of IOP.

Table 2. Intraocular pressure readings with Perkins, air and Diaton tonometers, and central and superior pachymetries before and after LASIK.

Parameter	Presurgery	Postsurgery	Presurgery – postsurgery	ρ value
IOP Perkins (mmHg) (mean (SD))	14.02 ± 2.25	11.85 ± 2.08	2.16 ± 2.47	p < 0.001*
IOP air tonometry (mmHg) (mean (SD))	14.92 ± 2.98	10.86 ± 1.71	4.05 ± 2.72	p < 0.001*
IOP Diaton (mmHg) (mean (SD))	14.18 ± 2.70	14.38 ± 3.50	–0.20 ± 2.73	0.590
Central pachymetry (µm) (mean (SD))	572.59 ± 45.41	475.91 ± 55.95	96.67 ± 44.83	p < 0.001*
Superior pachymetry (µm) (mean (SD))	658.62 ± 31.69	645.18 ± 29.41	13.44 ± 29.30	0.080

*Presurgery versus postsurgery. $p < 0.05$. Student's paired t-test.

The Goldmann applanation tonometry is accepted as the gold standard in IOP measurement but it seems that central corneal thickness is an important factor in this measurement overestimating the IOP on thick corneas and underestimating it on thin corneas. On the other hand, there is evidence that noncontact tonometry gives higher readings than Goldmann's, particularly in adult patients. This tonometry is also dependent on central corneal thickness. Regarding transpalpebral tonometry, there is discrepancy between authors on the accuracy of the instrument. Sandner et al. found a sufficient correlation between Goldmann and transpalpebral tonometry, concluding that Diaton may be a good tool for screening. However, other authors, did not find this correlation, probably for a substantial interexaminers variation. In our study, no correlation was found between Perkins tonometry and transpalpebral tonometry, probably due to a lack of reliability, described by others authors.

Our results showed that readings obtained with the Perkins and air tonometers, measuring the IOP in the center of the cornea and therefore in the ablation zone, were significantly lower after the refractive surgery when compared to the presurgery values. However, the transpalpebral tonometer, which takes the IOP in the superior zone of the cornea, showed the same values before and after surgery. It seems that the cause for this IOP decrease may be the central corneal thinning resulting from the surgery together with the biomechanical change of the cornea after the flap creation. Similarly, Shemesh et al. found that patients undergoing LASIK and LASEK treatments showed lower IOP after refractive surgery when measured with Goldmann applanation tonometry but not when measured with dynamic contour tonometry, which is apparently independent of central corneal thickness. Also, Shousha et al. concluded that IOP lowered after LASIKand epiLASIK treatmentswhen measured with both Goldmann and noncontact tonometry.

It could seem surprising the no correlation between SER before surgery and Perkins tonometry. This correlation is dependent on corneal thickness, K values, biomechanical characteristics of the cornea, and ablation diameter but it has been described that IOP after surgery is only dependent

on corneal thickness and K values, obtaining inaccurate IOP measures. This fact could be explaining the lack of correlation between Perkins tonometry and SER before surgery.

The main limitation of transpalpebral tonometer is inaccuracy in elevated intraocular pressure eyes, as there is evidence that Diaton underestimates the intraocular pressure measurement when compared to the gold standard Goldmann tonometry. More research is needed to validate the new methods to obtain an IOP reading nondependent on central corneal thickness, as the Diaton tonometer for glaucoma patients. Another limitation of the study is the difficulty to calculate the thickness on the limbus, exactly in the Diaton point ofmeasure. In our study, SCT was measured at 4.5mm of the central cornea to justify the no change in the peripheral thickness, but this is not exactly the point that the transpalpebral tonometer does themeasurement. The no correlation between SCT and Diaton tonometry indicates that lid biomechanics and thickness have an important role and therefore more studies about this topic would be necessary.

In conclusion, the transpalpebral tonometer may be useful to control the IOP after LASIK surgery as it does not depend on the ablation and thinning of the central cornea after myopic refractive surgery.

DISCLAIMER

The authors alone are responsible for the content and writing of the paper.

CONFLICT OF INTERESTS

The authors report no conflict of interests and no financial support.

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Change in Intraocular Pressure During Point-of-Care Ultrasound

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INTRODUCTION

Point-of-care ocular ultrasound (US) is a valuable tool for the evaluation of traumatic ocular injuries. Conventionally, any maneuver that may increase intraocular pressure (IOP) is relatively contraindicated in the setting of globe rupture. Some authors have cautioned against the use of US in these scenarios because of a theoretical concern that an US examination may cause or exacerbate the extrusion of intraocular contents. This study set out to investigate whether ocular US affects IOP. The secondary objective was to validate the intraocular pressure measurements obtained with the Diaton® as compared with standard applanation techniques (the Tono-Pen®).

METHODS

We enrolled a convenience sample of healthy adult volunteers. We obtained the baseline IOP for each patient by using a transpalpebral tonometer. Ocular US was then performed on each subject using a high-frequency linear array transducer, and a second IOP was obtained during the US examination. A third IOP measurement was obtained following the completion of the US examination. To validate transpalpebral measurement, a subset of subjects also

underwent traditional transcorneal applanation tonometry prior to the US examination as a baseline measurement. In a subset of 10 patients, we obtained baseline pre-ultrasound IOP measurements with the Diaton® and Tono-Pen®, and then compared them.

RESULTS

The study included 40 subjects. IOP values during ocular US examination were slightly greater than baseline (average +1.8mmHg, p=0.01). Post-US examination IOP values were not significantly different than baseline (average −0.15mmHg, p=0.42). In a subset of 10 subjects, IOP values were not significantly different between transpalpebral and transcorneal tonometry (average +0.03mmHg, p=0.07).

CONCLUSION

In healthy volunteer subjects, point-of-care ocular US causes a small and transient increase in IOP. We also showed no difference between the Diaton® and Tono-Pen® methods of IOP measurement. Overall, the resulting change in IOP with US transducer placement is considerably less than the mean diurnal variation in healthy subjects, or pressure generated by physical examination, and is therefore unlikely to be clinically significant. However, it is important to take caution when performing ocular ultrasound, since it is unclear what the change in IOP would be in patients with ocular trauma.

Tonometer through the eyelid diaton: accuracy and quick IOP reading

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Gaseta Remitido Cientifico, № 490, March, 2014

INTRODUCTION

Glaucoma is the pathology that mainly stems from intraocular pressure (IOP) rise and leads to intense damage of the visual nerve and loss of vision. It is the second most common cause of blindness worldwide. Nearly 4.5 million people are believed to have become blind due to the run of glaucoma and this number is going to exceed 10 million by 2020.

Glaucoma detection is based on IOP measurement, examination of the visual nerve (correlation «delve – mount»), of the visual field and measurement of the anterior chamber angle.

IOP measuring is the most widely spread way to detect glaucoma from the above-mentioned ones since the percentage of patients suffering from glaucoma whose IOP exceeds 23 mmHg is really high though there is still a group of patients who have normal IOP. Moreover, very high IOP does not mean that the patient is really suffering from glaucoma, but indicates a very high risk that he is prone to this disease. Therefore, it is necessary to make all diagnostic examinations to confirm the presence of pathology.

There are two types of tonometers suitable for IOP measuring. The first group is invasive tonometers measuring IOP on the cornea. The Goldman tonometer (GAT), Perkins and Icare belong to this group. The second group is contact free tonometers – pneumatic tonometers that measure IOP with the help of the air jet, and the tonometer measuring IOP through the eyelid – diaton.

PROS & CONS OF IOP MEASURING ON THE CORNEA

Tonometry based on cornea measurements, has a number of advantages and disadvantages. The main advantages are as follows:

a. Cornea is more accessible for tonometry in an open eye than sclera.

b. There are no other intermediate structures (conjunctiva, eyelid...) between tonometer and cornea.

c. Individual differences in thickness and curvature of cornea are less significant compared to other ocular structures.

On the other hand, it has several drawbacks:

a. Cornea is a tissue with high sensitivity, since the tissue is much innervated. This means that anesthesia is needed for contact tonometry.

b. Cornea is spherical only in the central zone; it becomes more flat and thick toward the periphery. These differences between the central and peripheral zones may significantly affect the measurement of IOP.

c. When making corneal tonometry it is difficult to prevent the increase in muscle spheroidal and palpebral tone, which causes increase in IOP.

d. When working with contact tonometers the tools should be very carefully sterilized.

e. Corneal tonometry is contraindicated in corneal edema, nystagmus, conjunctivitis, corneal erosion, keratitis and corneal ulcers.

TONOMETER THROUGH THE EYELID: DIATON

Diaton, the tonometer for measuring IOP through the eyelid, was developed by engineers and ophthalmologists; the purpose of the development: the device must be easy-to-operate and portable. It should have sufficient accuracy and quickly measure the intraocular pressure, be useful in diagnosing and monitoring the effectiveness of glaucoma treatment. The main feature of this tonometer: measurement is performed through eyelid, so, the direct contact with the cornea or (conjunctiva) of the mucous membranes is avoided,anesthesia is not required and there is no risk of infection during the measurement of intraocular pressure.

The measuring principle of the tonometer is based on the force analysis that is necessary for the rod movement when pressure is applied to the elastic surface of the eye. The main obstacle: to avoid influence of individual peculiarities of the eye during the IOP measuring procedure.

Technical designers solved this problem in the following way: pressure is applied on the section of 1,5 mm diameter so that the section under the pressure acts as hard surface and allows the rod to conduct the measurement without contact to the eyelid and without pain.

There are different research works, published in peer review tonometry magazines, which were held with the help of the tonometer through the eyelid. In 2005 Sandear et al have found sufficient correspondence between the Goldmann tonometer and the tonometer through the eyelid. They have come to conclusion that the tonometer through the eyelid is a good screening tool. In 2006 Doherty et al stated 0,8 correlation between the reading of the Goldmann tonometer and the tonometer through the eyelid. Moreover, the patients have given their preferences to the tonometry through the eyelid but not to the Goldmann tonometry. On the other hand, as it usually happens to air-puff tonometers or contact free tonometers there is some dissonance with the Goldmann tonometer. This fact is usually explained with the differences in the methodology of measurements used in different research works.

IOP DETERMINATION WITH DIFFERENT TONOMETERS AFTER TRANSLASIK

Doctor Isabel Cacho, specialist in optics and optometry at Balear Institute of ophthalmology together with Lenticon Laboratories have done a clinical trial of IOP changing after refractive corneal surgery LASIK. IOP is measured before and after refractive corneal surgery LASIK by means of three types of tonometers: contact corneal tonometry based on Goldmann system (Perkins), air-puff contact free tonometry and tonometry through the eyelid (diaton). The purpose of the trial is to estimate the influence of corneal thinning caused by refractive surgery.

Source: IOP screening after LASIK (IBO; Palma de Majorca)

This clinical trial is being continued but preliminary results (25 patients) present very interesting information. While carrying out the clinical trial it was observed the divergence of IOP readings measured with through the eyelid tonometer is not significant 0,54 mmHg decrease after surgery. In case of Perkins tonometry IOP decrease was more essential with the difference before and after – 2,48 mm Hg. IOP difference before and after surgery measured with contact free tonometer is more than 5 mmHg as long as this tonometer is less accurate. On the other hand, the difference between the results before and after surgery of Perkins and diaton is 0,5 mm Hg, and with contact free tonometer the difference is 1,30 mm Hg.

After that the changing of corneal thickness in the central zone and in the peripheral upper part after surgery was studied as well. The observed corneal thinning in the central part is 140 micron which is statistically significant and in the upper part the changing is not prominent – 15 micron.

These data prove that corneal thickness greatly influences the IOP results measured with contact free tonometer. However, after surgery corneal thinning does not influence the results while measuring IOP with the help of through the eyelid tonometer.

CONCLUSIONS

Through the eyelid tonometer diaton is a suitable screening tool for IOP measuring in patients with keratokonus,cornea pathologies,or in patients after refractive cornea surgery in order to see cornea thickness influence or some other cornea pathologies influence on IOP measuring result. Moreover, this device is easy, portable, does not require anesthetics, it can be used by a doctor to measure IOP in children, in people with limited mobility, in general, it can be used in each person who needs his IOP to be measured.

Agreement among Transpalpebral, Transcleral and Tactile Intraocular Pressure Measurements in Eyes with Type 1 Boston Keratoprosthesis

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ARVO, 2013

PURPOSE

The use of keratoprostheses (KPro) to restore vision in eyes with corneal opacities has become increasingly popular in the last five years. Intraocular pressure (IOP) is a cardinal measurement employed in glaucoma management. This presents a major problem since glaucoma remains a major visual limiting factor in eyes with KPro and most forms of tonometry require an intact cornea. The purpose of this study is to determine if transpalpebral IOP measurement can be an alternative method of measuring IOP and yield valuable data in eyes with KPro.

METHODS

We retrospectively reviewed IOP measurements in patients who had received Type 1 Boston KPro, and their IOP were estimated by three different methods during routine visits to their corneal surgeon. The surgeon estimated the IOP range tactilely by palpation of the globe. A pneumatonometer (Model 30 Classic; Mentor, BioRad, Santa Ana, California,USA) was used to measure IOP by placing the tonometer tip on the sclera peripherally to the contact lens in the inferotemporal quadrant. The Diaton tonometer (Long Beach, NY, USA) was used to obtain values through the upper lid in accordance with the instructions by the manufacturer. An average of two Diaton IOP measurements was used in the analysis. Since the tactile IOP were

recorded as a range rather than a definite number, we computed the percent agreement, the percentage of eyes in which pneumatometer or Diaton IOPs were within 2 mmHg of the tactile IOP range. Two-tailed t-test was used to compare the mean of pneumatonometer and Diaton IOP measurements.

RESULTS

The analysis included 23 eyes of 20 patients. The percentage agreement was 85% between tactile range and pnematonometer IOPs, and 95% between tactile range and Diaton IOPs. Pneumatonometer consistently yielded higher IOP values, compared to Diaton ($p = 0.04$). The overall IOP mean ± SD was 17.2 ± 6 mmHg for pneumatonometer and 13.8 ± 5 mmHg for Diaton tonometer.

CONCLUSIONS

The presence of KPro did not appear to interfere with IOP with Diaton tonometer, and Diaton tonometer yielded IOP readings that were similar to those obtained by palpation. Scleral pneumotonometry yielded values that were consistently higher than tactile estimates and Diaton IOP. In addition to routine IOP estimates by palpation, transcleral and transpalpebral IOP measurements can be considered to monitor patients with KPro.

Comparative agreement among three methods of tonometry: Goldmann applanation, diaton traspalpebral and dynamic contour

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Glaucoma: care and research, Mexico

ARVO, 2013

PURPOSE

To investigate agreement of intraocular pressure (IOP) as measured by the Goldmann applanation tonometer (GAT), the Pascal dynamic contour tonometer (DCT), and diaton transpalpebral tonometer (DTT).

METHODS

Device agreement was calculated by Bland-Altman analysis in 77 eyes of 40 individuals (mean age 58.9 ± 13 years) with a mixed diagnosis of glaucoma suspicion and primary open-angle glaucoma. All measurements were performed in a random order by the same clinician according to standard procedures.

RESULTS

Mean IOPs ± S.D. were 14.4 ± 2.9 mmHg (GAT), 18.8 ± 3.2 mmHg (DCT; P = 0.005, ANOVA), and 15.1 ± 3.1 mmHg (DTT). Bland-Altman analysis demonstrated that, on average, DCT IOP measurements overestimated in approximately 3 mm Hg, values derived from GAT and DTT, although agreement was fairly good.

CONCLUSIONS

All methods of tonometry were adequate to measure IOP in our sample. Agreement among devices was considered good; nevertheless, DCT values of IOP were significantly higher as compared to the other two assessed methods.

Comparison of IOP measurements between Goldmann Applanation Tonometry and Ballistic Principle Diaton Tonometry in several groups of patients

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Director Dr. A. Polychronakos

Ophthalmological Congress, Athens, Greece, 2011

PURPOSE

To compare the intraocular pressure (IOP) between the Goldmann with Applanation Tonometry and the Ballistic Principle Diaton Tonometry above the eyelids in different groups of patients. Diaton tonometer can be used as an alternative device for the screening of population and the diagnosis of glaucoma at its early stage.

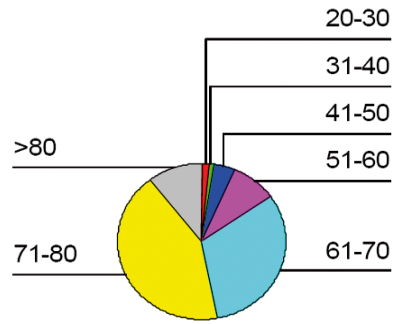
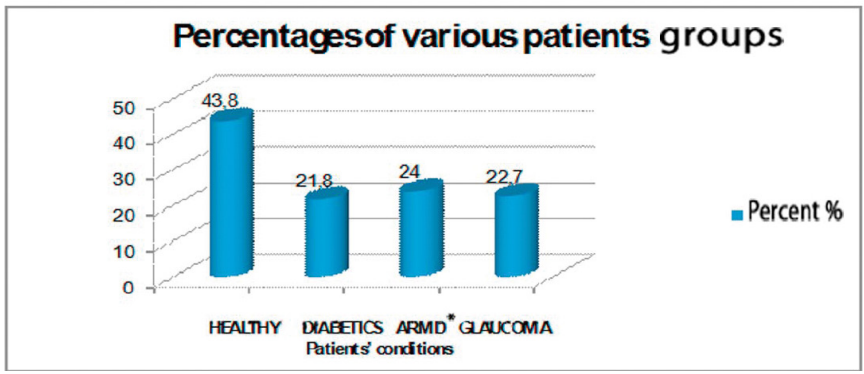


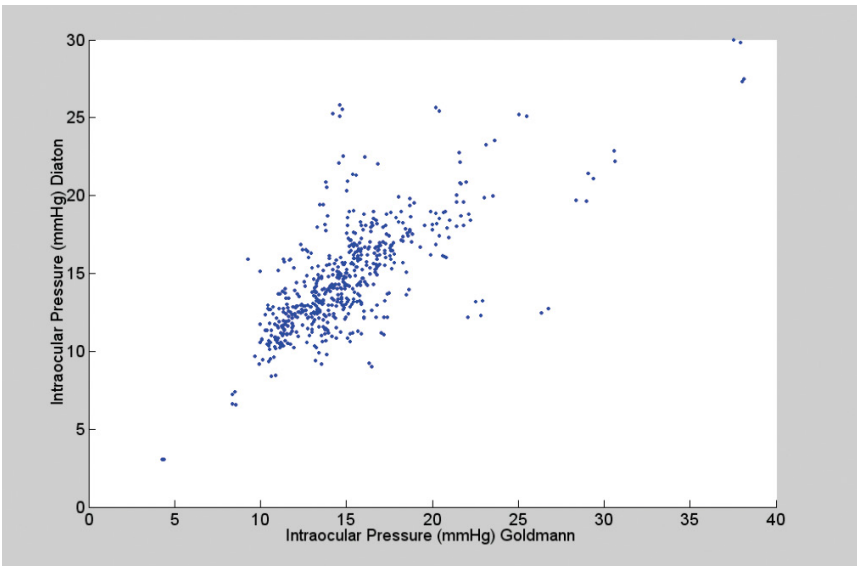
Figure 1



***ARMD — age-related macula degeneration**

METHODS

572 eyes of 287 patients were studied. The selection of patients was random. There were 45,5% of males and 54,5% of females of various ages in the group. The overwhelming majority of the patients were more than 60 years old (Figure 1). The research group contained the patients suffering from glaucoma (22,7%), ARMD (24%), diabetics (21,8%) and healthy patients (43,8%). Obviously, there were a few patients that suffer from glaucoma and simultaneously they were diabetics. The intraocular pressure was measured in both eyes from all the above patients with the exception of 2 to whom it was measured only one eye. The IOP was measured with the Goldmann and the Diaton tonometer and the values were recorded. The measurements with the Goldmann tonometer were carried out by all doctors of the clinic whereas the measurements with the Diaton tonometer were carried out by the same doctor and always with the same method. The patients were in sitting or lying position during the examination with the Diaton tonometer.



Scatter Plot

RESULTS

There was statistically significant correlation between the measurements of both tonometers ($p < 0.001$). 83,11% of the research group had absolute difference between the values of the two measurements up to 2 mm Hg. There is also significant correlation between the «absolute difference between the values of the two measurements» and glaucoma ($p < 0,05$). Moreover, absolute difference between the values of the two measurements seems to be related with age but more measurements are needed to verify this relation statistically. For the so-called «healthy», divergence between the measurements of the 2 tonometers greater than 5mmHg is observed for less than 5% of the sample, whereas for the patients with glaucoma divergence greater than 5mmHg is measured for the 15% of the sample. There is no correlation between divergence and parameters such as gender, diabetes, ARMD, thyroid ophthalmopathy, refractive abnormalities and cataract ($p>0,05$).

Diversion of measured value	Frequency	Percent %	Cumulative Percent %
0	170	31,10	31,10
1	182	33,28	64,39
2	102	18,71	83,11
3	28	5,14	88,25
4	21	3,36	96,1

Deviation between measurements

CONCLUSIONS

Ballistic Principle Diaton Tonometry can be used as an alternative for the measurement of the intra-ocular pressure above eyelids for patients with recent ocular surgeries, after refractive surgeries, with severe corneal injuries, with corneal apoptosis of epithilium and with large pterygium. Additionally, children can be measured easily with Diaton for IOP and also it can be used in patients with mobility problems.

Comparison of Accuracy of Diaton Transpalpebral Tonometer Versus Goldmann Applanation Tonometer, Dynamic Contour Tonometer and Ocular Response Analyzer

Henry D. Perry, M.D.[1]; S.E. Avetisov, M.D.[2]; V.P. Erichev, M.D.; A.A. Antonov, M.D.; A.R. Illarionova, M.D.[3]

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AAO, 2011

PURPOSE

To compare intraocular pressure measurements obtained with the diaton transpalpebral tonometer with those from ocular response analyzer (ORA), dynamic contour tonometry (DCT) and Goldmann applanation tonometry (GAT) in patients diagnosed with primary open-angle glaucoma (POAG) and glaucoma suspects, and to determine the effects of central corneal thickness (CCT) and corneal hysteresis (CH) on intraocular pressure (IOP) measurements with these devices.

PATIENTS

40 patients (80 eyes) age 42-83 years with POAG and glaucoma suspects were included in the study.

Research exclusion criteria:

- Patients who came through the eye surgery;
- Patients with cornea, sclera and lid pathology;
- Patients with high-grade myopia or hypermetropia;
- Patients with visual acuity less than 0,1

METHODS

IOP was estimated using: Goldmann Applanation tonometer, Ocular Response Analyzer, Dynamic Contour tonometer, Transpalpebral Non-corneal Diaton tonometer.

• CCT was estimated using ultrasonic pachymeter that was built-in ORA

• The average of ORA (corneal compensated IOP [IOP-ORAcc] and Goldmann-correlated IOP [IOP-ORAg]), DCT, GAT, and Diaton tonometer levels were compared and the devices were examined with respect to CCT and CH

• Spearman's correlation tests were used for statistical analysis

RESULTS

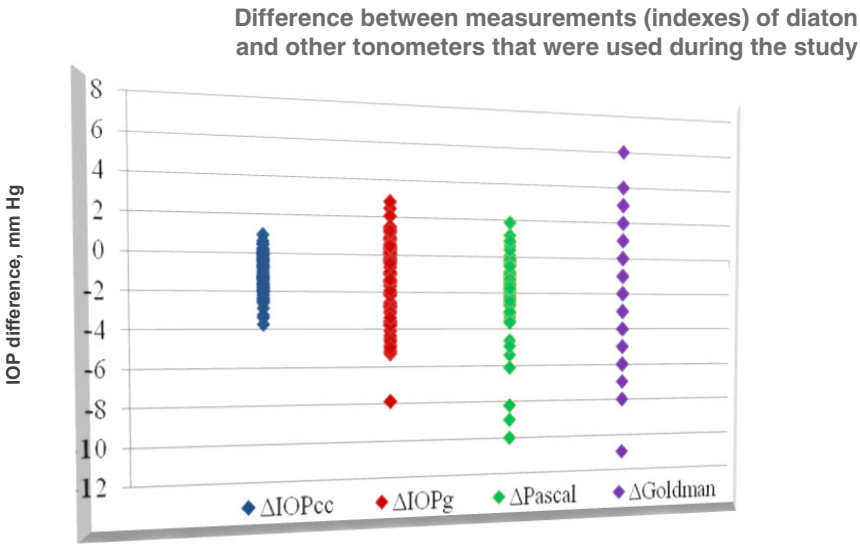
	IOP, mm Hg	
	M±σ	Min/Max
GAT	18,4±4,1	11/31
ORA IOPg	18,4±3,5	12,6/28,0
ORA IOPcc	18,2±3,4	10,5/29,7
DCT	18,9±4,1	10,1/33
Diaton	17,0±3,0	10/28

- Mean CCT was 561,2±32,4mum and mean CH was 10.6+/-2.0 mm Hg
- Mean IOP, measured with the tonometers that were used in the research

Correlated rates relations

	Diaton	ORA IOPcc	DCT	GAT
Diaton		0,96	0,87	0,61
ORA IOPcc	0,96		0,89	0,56
DCT	0,87			0,73
GAT	0,61	0,56	0,73	

The performed analysis of correlation between IOP meanings shows high conformity of results of Diaton with IOP-ORAcc and DCT.



The differences between the measurements of DCT, ORA and Diaton were statistically significant.

CONCLUSIONS

Transpalpebral tonometry is an accurate method of IOP measurement that is also independent from the biomechanical characteristics of cornea.

It can be recommended for IOP measurements of patients diagnosed with glaucoma including those cases where cornea pathology or cornea characteristics have been altered.

Accuracy of Transpalpebral Tonometer Compared to Goldmann Applanation Tonometer in Normal and Glaucomatous Eyes

M.A. Latina [1], T.A. Shazly [2], R. Iospa [3], E.W. Chynn [4]

[1] Reading Health Center, Reading, MA;

[2] Ophthalmology, Massachusetts Eye and Ear Infirmary, Boston, MA;

[3] Bicom, Inc., New York, NY;

[4] Park Avenue Laser Vision, New York, NY

ARVO, 2011

PURPOSE

To compare intraocular pressure measurements obtained with the Diaton, a new digital transpalpebral indentation tonometer, with those from Goldmann applanation tonometry (GAT) in normal and glaucomatous eyes.

METHODS

Sixty six eyes of 33 consecutive subjects,46 eyes having glaucoma and 20 eyes without glaucoma, were included in the study. Patients were excluded with clinically significant lid, scleral or motility disorders, a history of recent intraocular surgery or previous trabeculectomy, glaucoma shunt, or scleral buckle.

Goldmann tonometry was perfomed by one of the authors, while the diaton measurements were performed by another author in a masked fashion.

Applanation measurements were performed in a upright sitting position taking two IOP readings. diaton measurements were performed until the device signaled acceptable measurements, with the back of the chair reclined to achieve a horizontal head position.

RESULTS

The age ranges: glaucoma group — 46 to 90 years (69.37 + 10.07): normal group — 62 to 88 years (76.85 + 9.07).

Goldman applanation IOPs for the normal group ranged from 11 to 19 mmHg (mean 14.55 and SD, 2.32), while the diaton measurement for the same group ranged from 12 to 19 mmHg (mean 14.95 and SD, 2.21).

For the glaucoma group, the Goldman applanation IOP ranged from 6 to 31 mmHg (mean 15.42 and SD, 4.77, while the diaton measurement for the same group ranged from 9 to 31 mmHg (mean 16.13 and SD, 4.30).

The Pearson's correlation coefficient (r) between Goldman applanation pressure and diaton pressure was 0.725 for the whole group (66 eyes, $p < 0.01$) and 0.778 for the glaucoma group with $p < 0.01$.

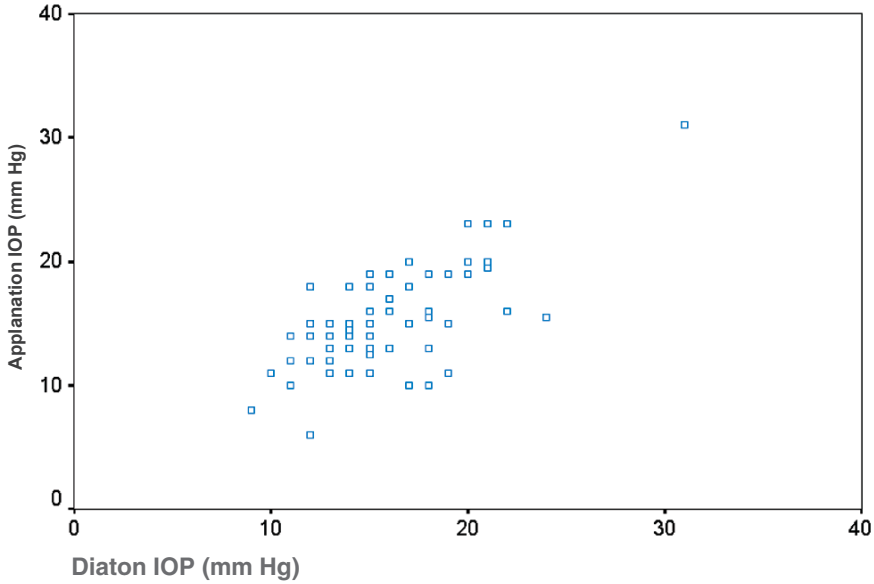
In both normal and glaucoma groups, 15.15% of the diaton measurements exactly the same as the Goldman applanation tonometer, diaton under-estimated the IOP compared to the applanation pressure in 37.87% (1-6 mm Hg), and over-estimated the IOP by (1-8 mmHg) in 43.93% of the eyes tested.

The difference between diaton and GAT reading was ≤ 1 mmHg in 51.51% of eyes measured,≤ 2mm Hg in 65.15%, ≤ 3 mmHg in 83.33%, ≤ 4 mmHg in 89.39%, and was 5-8 mmHg in 10.6% of eyes measured.

Difference between Applanation and diaton readings

IOP Difference (mm Hg)	Percentage
≤ 1	51.51%
≤ 2	65.15%
≤ 3	83.33%
≤ 4	89.39%
5-8	10.6%

Agreement between Applanation and diaton readings



CONCLUSIONS

The diaton, a transpalpebral measurement device,which avoids corneal contact,correlates within 3 mmHg of Goldmann applanation tonometry in 83.3% of eyes in this limited study. Diaton tonometer may be a clinically useful screening device for measuring IOP.

Handheld tonometer offers simple, reliable way to measure IOP Pen-like tonometer designed to be patient-friendly

Jennifer A. Webb
Reviewed by John Hope, M.D.; and Mark Latina, M.D.
(Abstracts from two publications in Ophthalmology and Optometry Times)

Long Beach, NY-A handheld tonometer that measures intraocular pressure (IOP) through the eyelid and over the sclera is proving helpful for optometrists faced with patients who are apprehensive about seeing an instrument approaching their eyes or who have a corneal abnormalities.

The tonometer Diaton is a pen-like instrument that measures IOP within seconds without the need for anesthesia or sterilization. The instrument has been the subject of numerous clinical trials, where it has been found comparable to the eye doctor's «gold standard» – the Goldmann applanation tonometer.

The device appeals to optometrists and ophthalmologists who see pediatric patients and those with patients who have corneal edema or erosions, or have keratoprostheses. Because the device is used on the upper eyelid, out of the patient's field of vision as they recline and look at a 45-degree angle, they do not tend to blink or squeeze their eyes shut prior to the reading, which can skew the IOP measurement.

«It is convenient for the doctor and painless for the patient», the company's CEO, Roman Iospa said. «There is really no discomfort, especially for the patient who might be slightly anxious».

H. Arnold Papernick, OD, an optometrist in private practice in Mt. Pleasant, PA, said the device has been helpful when examining pediatric patients or anyone who is averse to objects coming at their eye. Excessive blinking can cause IOP measurements to read abnormally high, he explained.

Mark Latina,MD,and Tarek Shazly, MD, members of the Department of Ophthalmology, Massachusetts Eye & Ear Infirmary, Boston, MA, and Emil William Chynn, MD, an ophthalmologist in private practice at Park Avenue Laser in New York, coordinated a study of Diaton tonometer to compare IOP measurements taken with Diaton with those from the Goldmann applanation tonometer in normal and glaucomatous eyes.

In both the normal and glaucoma groups, 15.15% of the Diaton measurements were exactly the same as those obtained with the Goldmann tonometer. Diaton under-estimated the IOP compared with the Goldmann in 37.87% of eyes, and over-estimated the IOP in 43.93% of eyes.

Meanwhile, John Hope, MD, an ophthalmologist in private practice in Okahoma City, OK, and a diplomate, American Board of Ophthalmology, said he is impressed with the instrument and prefers it because patients «hate the non-contact tonometry» and applanation tonometry is time consuming and often requires support staff. He has used the instrument routinely on every patient for at least six months.

Eye pressure measurement for glaucoma detection and treatment

Tuomilehto H., Seppa J., Partinen M., Gylling H., Vanninen E., Kokkarinen J., Sahlman J., Martikainen T., Randell J., Tukiainen H., Uusitupa M.

Seppo similä LKT company, the head of research, Pedihealth Oy Company, Oulu, Finland

Terveydenhoitaja, No.3, 2009

One of the risk factors of glaucoma development is the intraocular pressure increase. To decrease the progression risk of the disease it is necessary to prevent the progression of glaucoma optical neuropathy. It is necessary to learn to use devices for eye pressure measurement correctly. Pressure measurement in the superior eyelid area is safe and does not give patients any troubles. It is easy to learn the operation method of the device after a short familiarization for the medical personnel of the health centers. This article is based on the training program of students Ricca Ervasty and Yenny Nousyaynen, which was held in autumn 2008.

Glaucoma (from ancient Greek «greenness of sea») is the disease caused by a disturbance of the intraocular pressure regulation, the progressive damage of an optic nerve. Glaucoma symptoms can be unnoticed for a long time. The reasons of disease are not studied entirely. In 2006 in Finland there were 72,223 people with glaucoma, among them 24,049 were men and 48,174 were women. According to research nearly half of them did not feel any symptoms. People over 45 need to examine their eyes once a year, and people over 60 should visit ophthalmologists more often. It is also recommended to reduce intervals between medical examinations for people with myopia as well as for people with a genetic predisposition to the disease. The treatment should correspond to age-related changes, eye pressure measurement results and ophthalmologist's examinations.

The eye examination of drivers at health centers is limited to visual acuity and visual field check only. The eye pressure measurement is made exclusively at people with

evident symptoms of glaucoma or in connection with the disease detection. The glaucoma treatment in a health center is based on eye pressure measurement results and ophthalmologist's research. As medical and optical services in our country are unevenly distributed, glaucoma detection and its diagnostics are not carried out in full.

Table 1. Glaucoma detection at an early stage through the eye pressure measurement. Relates to a risk group

Risk factors	Risk volume
Age	Before 40 y.o. 0,6%, over 40 y.o. 1,5%
Eye pressure 22-29 mm Hg	10-13 times
Myopia (short-sightedness) over -3D	2-4 times
Pseudoexfoliation	5-10 times
Genetic predisposition	3-9 times
Hypermetropia (long-sightedness)	Small anterior chamber, visual field limitation
Diabetes, blood-vessel diseases	Extensive risk

The disturbance of the intraocular pressure regulation is the most important and common factor leading to an optic nerve damage and glaucoma,visual field reduction and finally blindness development. However, the disturbance of the intraocular pressure regulation is not the only reason of all glaucoma cases,since researches have shown that approximately half of patients at the incipience had standard 10-21mmHg pressure and the optic nerve damage at the same time. So every case is individual.

The glaucoma diagnosis is made on the basis of eye pressure measurement results, optic nerve examination, visual field and anterior chamber angle (gonioscopy). Nevertheless, nowadays there is no description of diagnostics criteria for glaucoma and uniform terminology. Actions on the glaucoma diagnostics require joint efforts of health centers, opticians and ophthalmologists. The task of the local health centers is to reveal a risk group through the eye pressure measurement and carry out the further glaucoma treatment.

INTRAOCULAR PRESSURE MEASUREMENT

The intraocular pressure measurement or ophthalmotonometry,primary actions on the disease recognition are the important part for the eye state examination. Tonometry is expressed in an intraocular pressure (IOP) value mmHg.

There are different methods of examinations by opticians, therapists and ophthalmologists. Opticians rely on intraocular pressure measurement results and ophthalmologist's conclusion. An ophthalmologist examines eyes completely. A therapist defines visual acuity, a visual field, carries out eye ground examination and measures intraocular pressure. When measuring pressure, eye elasticity is applied, which allows measuring pressure on the external side.

The technique of intraocular pressure measurement with devices is based on external pressure for visual organ deformation and its interpretation. The more external pressure is required for eye deformation, the more internal pressure. For the pressure measurement both devices are used, contact an eyeball (CT or contact tonometer) and not-contact (NCT non-contact tonometer). For the pressure measurement with contact devices it is necessary to fix an eyeglobe, these actions are carried out by a doctor or a nurse under the doctor's supervision. Opticians use a noncontact method that provides speed,accuracy and good results.

EYEGLOBE CONTACT METHOD

Schiotz tonometer (indentaa tonometri) is the oldest manual tonometer which is used so far. During procedure the patient lies, his eyeglobe is fixed; the device is set on a cornea. Pressure on the cornea is performed with the device. The more pressure, the less depression on the cornea. The result is shown on a mechanical scale in mmHg value. For the intraocular pressure measurement Goldmann tonometer (GAT tonometer) has been considered as a «gold standard» for a long time. It is used as a standard for all devices measuring eye pressure. The tonometer usually joins a corneal microscope, and results are obtained under the examination control. For the measurement with this tonometer is necessary to fix an eyeglobe, and the procedure is carried out by a doctor.

ELASTOTONOMETER

Measurement with elasto-tonometer iCARE does not require fixation on an eyeglobe. During measurement the disposable sensors, which easily and cautiously contact with cornea are used. The activity of this device is grounded on an electromagnetic induction. Advantage of the device is the speed and minor propulsive energy (speed up to 0,3 m/s, weight 26mg). Frequently patient at all does not feel a procedure.

The study of elastotonometer have begun in Finland in the second half 1990. The device was introduced on the market by Tiolat Oy corporation in autumn 2003. At once it has received wide distribution in Finland and strongly has taken the place in medical practice as practically alone device.

NON-CONTACT TONOMETERS

The first contactless tonometer was shown in 1972. In the basis of its activity lies the technique of an air injection on a cornea of an eye (Air-puff) / Results of research – by quantity of uniformly injected air on a cornea of an eye. The further modifications of the device have made it convenient in maintenance. Now different models are used in practice,such as Keeler, Pul-sar and Reichet. During a procedure the patient sits, the optical motions are formed by air weight of a metering tonometer. The device has a small size, it is convenient for transportation.

TONOMETERS METERING PRESSURE IN THE SUPERIOR EYELID OF AN EYE

Technique of measurement with Diaton tonometer, grounded on measurement of elasticity of an eye is conducted by free pressure for the superior eyelid by a rod of the device. The device measures the value automatically, according to eye pressure in mm Hg. The device has the small size (17,4x2,6x2,0см), light (89gr), outwardly resembles the pen.

Table 2. Advantages and disadvantages of Diaton tonometer in comparative research with other devices

Advantages	Disadvantages
Does not cause anxiety to the patient	Dependent on professionalism of staff which is making measurements
Speed of measurement	Effecting the result of position of an eye-globe, line of sight fixing
The simplicity of measurement	A buzzer can trouble the patient
Reliability of measurement	Slight tingling of eyelid
Measurement in lying positioning	Inconvenient for patient sitting position
Self-sufficiency	Hazard of switching-off during a procedure
The device is of the small size, is convenient for transportation	Requires a special case

The device is designed in Russia at Ryazan State Instrument-making Enterprise. At realization of a procedure the patient is preferentially lies on his back. He is asked to look upwards angularly 45 degrees. The tip of the device is set close to eyelashes edge so that it will be placed in the middle of imaginary vertical to an eyeglobe. For correctness of the installation the device is provided with beep. If the device is established not upright, the buzzer sounds, at the exact installation the buzzer becomes silent. The measurement is made up to 6 times, the average result is injected on the display by pressing the key.

MATERIALS ON TONOMETERS STUDY

By order of the company Pedihealts Oy within the framework of the OAMK program training of the students, developed by Ricca

Ervasty and Yenny Nousyaynen, the testing was conducted for matching activity of three different devices Keeler Pulsair, Reichert Opth-thalmic and Diaton. 120 persons participated in testing, the measurement of pressure was conducted on both eyes. Age groups 20-85 years. Average value by results of measurement of all three tonometers of the right eye 11,7, left eye 11,74 mmHg. In the table 2 the average values and their dispersions (mmHg), obtained at measurement by different devices are shown. The results,obtained by different tonometers, slightly differ, but there is no considerable distinctions for statistics. By materials,only three probationers had pressure more than 20 mmHg.

Table 3. Average values and their dispersion, obtained as a result of measurement by different devices

Tonometer	Total	Right eye	Left eye
Keeler	119	13,13+1,50	12,73 ± 1,79
Reichert	119	10,41 ± 1,70	10,32 ±2,11
Diaton	120	11,53 ±2,60	12,02 ±3,12

The straight regression would be more informative, if the tested group included more patients with ophtalmohypertension. Unfortunately, there is no sufficient material in Finland.

In the USA at Colorado university Theodore H. Curtis, Douglas I. Mackenzie, Robert J. Noecker and Malik Y. Kahook have made the comparative analyses of results of measurement of an eye pressure for the patients suffering from glaucoma in hospital by Diaton and Tono-Pen devices. Average pressure on Diaton 16,24 mmHg, on Tono-Pen 16,37 mmHg. Comparative boundaries of eye pressure – 8-33mmHg and straight regression under the analysis y=0,9955x. By the results of analyses Diaton was recognized the best device for measurement of eye pressure for adults and children.

THE PREVENTIVE MEASURES OF ORGAN VISION DAMAGES

The purpose of detection and treatment of glaucoma is preventing the development of blindness. For today there are not enough researches, dedicated to preventive measures of organ vision damage. The purpose of detection and treatment of glaucoma is preventing the development of blindness. For today there are not enough researches, dedicated to preventive measures of organ vision damage.

The hazard of glaucoma disease is magnified with age. In the age group higher 50 years it is detected on the average for 1,5-2,0 %. Seven times there are more people with suspicion on glaucoma, that equals to the sum of all ill.

For the last five years the reduction of field boundaries of vision for 5 % of the patients is marked, for them the eye pressure was considerably increased. For the same period quantity of people suffering from glaucoma from initial stage up to full blindnesses in the age of 30-40 years has increased. In the age group 70-79 years detection and the treatment of a glaucoma is ordered. Nevertheless, in the ordered program the poor notice is given to researches of disease. The development of tonometers considerably simplified intraocular measurements. Now these devices are used in all health centers. Today it is necessary to activate detection of glaucoma.

Transpalpebral diaton tonometer: what's ahead in 2007? Decking the halls with new products from 2006

Maxine Lipner, EyeWorld Senior Contributing Editor

EyeWorld Magazine February 2-5, 2007

One product potentially on the ophthalmic wish list is a unique new ocular pressure measuring device that received Food and Drug Administration (FDA) approval this year. The pen-like device, dubbed the transpalpebral Diaton tonometer (Long Beach, New York) measures intraocular pressure (IOP) through the eyelid and requires no direct contact with the cornea, as other methods have previously necessitated.

Henry D. Perry, M.D., clinical professor of ophthalmology, Cornell Weill School of Medicine, New York, said the device is much less anxiety-provoking for people. «Patients often have a fear of anything coming toward their eyes», he said. «there is less guarding and fewer false readings as when somebody squeezes their eyelids».

The transpalpebral tonometer works by pressing it to the eyelid and depressing a plunger that gently hits the lid. «By the amount of pressure exerted on the plunger when striking the eyelid and slightly indenting the globe, it can judge the IOP within 2to 4 mm HG,when compared with the Goldman applanation tonometer (Haag Streit, Mason, Ohio), which is the standard of care», Dr. Perry said.

He said he did a study where he evaluated 100 consecutive patients and found a 95% correlation with the Goldman tonometer, proving its accuracy. However, there is a bit of a learning curve for some technicians. Dr. Perry said there was one technician in his practice whose results were always precise, while others had outcomes that varied.

Dr. Perry said the new handheld tonometer, has a good fit for screenings in large clinics, where technicians or optometrists may be in charge. «I think in settings like that it may be easier to use», Dr. Perry said. It may also be better for children.

Transpalpebral tonometer application during intraocular pressure evaluation in the patients with refraction anomaly before and after keratophotorefractive surgery

Prof. A.P. Nesterov, M.D.; T.B. Dzhafarli, M.D.; A.R. Illarionova, M.D.

Russian State Medical University, Moscow

ASCRS, 2008

Cornea, as the basic optical lens of the eye,is the main element to be influenced during various,and first of all laser, surgeries with refractive, reconstructive, optical and other purposes.

Great success of the modern keratorefractive surgery, especially excimerlaser cornea microsurgery (FRK, LASIK, LASEK, Epi-LASIK) and its wide spread require high attention to the eye morphophysiological rates in pre- and postoperational period. The most important rates are still the characteristics of the cornea, such as thickness and its changes, regenerative response of corneal tissue and its regulation,as well as the data of intraocular pressure (IOP) and their correlation with cornea metrical rates.

According to the data of numerous investigations, underestimation of IOP level during applanation tonometry in patients, which were subject to keratophotorefractive surgeries, is of great importance in glaucoma diagnostic search. Hence, the advantages of scleral tonometry application in this category of patients for ophthalmotone appropriate evaluation and timely ophthalmohypertension detection are clear.

PURPOSE

The purpose of the study is to evaluate the clinical use of transpalpebral scleral tonometry, reliability of its application in the patients with refraction anomaly in pre- and postoperational period, dynamics of eye morphometric rates (pachymetry of the central corneal zone, IOP) and their correlative bond before and after photorefractive surgeries.

METHODS

We have analyzed the results of prospective comparative case series clinical study in 98 patients (194 eyes) with ametropia of various degrees, among which 59 persons (118 eyes) form the group of patients, who have no keratophotorefractive surgeries in past history, and 39 patients (76 eyes), which were the subject to excimerlaser vision correction (Epi-LASIK, LASIK, FRK) with various length of postoperational period from 7 days to 4 years.

The patients age distribution was from 18 to 53 years, the women make 61%, the men - 39%.

The following factors were exclusion criteria from the study:

- Cornea pathology, influencing prognosticly the applanation tonometry results;
- Upper eyelid and sclera pathology, which are the contraindications for transpalpebral diaton-tonometry.

Before and after the surgery all patients were subject to the complete refractive examination, including keratotopography and wavefront-aberrometry (AMO, USA). In a number of patients for cornea state morphologic evaluation we conducted US-biomicroscopy of the corneal optical zone before and in two months after laser correction.

Before and after surgery we trice measured pachymetry corneal thickness in central (4 points) zone – central corneal thickness (CCT) in each patient. We realized the study using two devices: US-pachymeter UP 1000 by NIDEK (Japan) and A-scan-pachymeter P55 by Paradigm (USA). IOP was measured with Goldmann applanation tonometer (Rodenstok, Germany), pneumotonometer (NIDEK, Japan) and transpalpebral scleral diaton tonometer (RSIME,

Russia, picture 2) using traditional methodology, all ophthalmotone measurements were realized the patients being in the sitting position with time interval being 2-3 minutes between two investigators.

The surgeries were carried out using excimer laser VISX Star S4 IR (AMO, USA), microkeratome LSK Evolution II (Moria, France) and epikeratome Centurion SES (Norwood, Australia).

Statistical treatment of the received results was realized using common methods of medical mathematical statistics. Statistic calculations were carried out using «Analysis Tools Pack». Determination of differences reliability between the groups being compared in the presence of normal distribution in sampling of one-type factors was realized using two-sample t-tests. Correlation analysis by Pearson allowed detecting the character of correlations between showings. Correlation with $P<0,05$ was considered to be reliable.

RESULTS AND DISCUSSION

In 93,6% cases visual acuity without correction after surgery was 0,6 - 1,0 (Table 1) in the early postoperative period.

Results of the study are shown in Tables 2and 3.

While analyzing morphometric parameters in the group of patients which were not the subject to photorefractive surgeries the mean PCT value was 554,5±32,4 μm, and the mean value of applanational IOP – 16,1±2,6 mm Hg, the fluctuation being from 10 to 21 mm Hg; mean ophthalmotone level evaluated with diaton tonometer – 14,7±2,5 mm Hg,the fluctuation being from 9 to 20 mm Hg. At that correlation between values of the applanation tonometer and transpalpebral scleral diaton tonometer was highly reliable ($r = 0,73, p±0,005$). To define the advantages of scleral tonometry in comparison with the traditional keratoapplanational method we made calculations of real ophthalmotone in the patients of this group taking into account pachymetry (PCT), ophthalmometry and applanation tonometry data. Mean value of the real IOP after applanation value converting was 15,4±2,4 mm Hg. Pearson correlation coefficient between real IOP (modified result, received with

applanation tonometry) and the value, determined with diaton tonometer was 0,89, p<0,005, which shows high reliability of transpalpebral scleral tonometry.

In the groups of patients, underwent photorefractive vision correction, mean PCT was 499,8±50,9 μm (fluctuations from 407 to 513 μm), mean applanation value of IOP – 12,4±2,91 mmHg (fluctuations from 7 to 20 mm Hg), modified taking into account keratometry IOP rates – 13,9±3,0 mm Hg, mean diaton-tonometry result - 15,1±2,75 mm Hg. At that we notice approximation of diaton-tonometry figures to the modified applanation IOP value taking into consideration keratometric rates – increase of correlation coefficient from 0,51 to 0,81 (table 4).

Correlation analysis of PCT and IOP results in the group of patients, examined both in preoperational period and after photorefractive vision correction showed reliability of this correlation, p<0,005, reduction of IOP for 1 mmHg is registered PCT being decreased for 29,7 μm. At that difference between pre- and postoperational IOP during applanation tonometry was 3,5 mmHg, and during diaton-tonometry – 1,8 mmHg, that is statistically dissimilar (t>2, p<0,005), which shows significant advantage of ophthalmotone evaluation if we omit cornea.

CONCLUSION

Thus, cornea thickness is the important factor of IOP evaluation and monitoring and requires the necessity of including corneal pachymetry in the program of examination the patients with suspicion of glaucoma and hypertension, especially after various keratorefractive surgeries while using the traditional corneal methods of ophthalmotonometry. At the same time clinical application of transpalpebral scleral diaton tonometer makes it possible to evaluate IOP using only one device, the procedure being efficient, economical, simple in performance and requiring no additional instrumental examination.

Comparison of the Diaton Transpalpebral Tonometer Versus Goldmann Applanation

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FINANCIAL DISCLOSURE

The authors have no financial interest in the subject matter being presented.

BACKGROUND

Diaton tonometry is a unique approach to measuring intraocular pressure (IOP) through the Eyelid. It is a non-contact (no contact with cornea), pen like, hand-held, portable tonometer. It requires no anesthesia or sterilization.

PURPOSE

To investigate the agreement in the measurement of intraocular pressure (IOP) obtained by transpalpebral tonometry using the Diaton tonometer versus Goldmann applanation in adult patients presenting for routine eye exams.

METHODS

Retrospective chart review of consecutive IOP measurements performed on 64 eyes of 32 patients age 34-91 years with both the Diaton tonometer and Goldmann applanation. Results between groups were examined using analysis of variance (ANOVA) where appropriate.

RESULTS

Mean IOP was 15.09 +/-4.31 mmHg in the Goldmann group and 15.70 +/-4.33 mmHg in the Diaton group (p=0.43).
Mean IOP variation between groups was 1.74 +/-1.42 mmHg (range 0-8). 83% of all measurements were within 2 mmHg of each other.

CONCLUSIONS

The transpalpebral method of measuring IOP with the Diaton tonometer correlates well with Goldmann applanation. Diaton may be a clinically useful device for measuring IOP in routine eye exams.

Comparison of the Diaton Transpalpebral Tonometer Versus Tono-Pen Applanation

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FINANCIAL DISCLOSURES

None of the authors have financial interests relevant to the supject discussed.

PURPOSE

To compare intraocular pressure (IOP) measurements obtained with Diaton transpalpebral tonometry versus Tonopen applanation tonometry in children and adults.

INTRODUCTION

Goldmann applanation is the gold standard for IOP measurement

It has been supplanted by TonoPen applanation in many settings because of it's ease of use, portability, convenience, and minimal training requirements.

The TonoPen requires contact with the corneal surface, and has the risks of iatrogenic corneal injury, spread of pathogens, and requires topical anesthetics.

INTRODUCTION

The newly-developed Diaton tonometer is a handheld device that measures pressure through the tarsal plate.It avoids contact with the cornea and the need for topical anesthesia.

METHODS

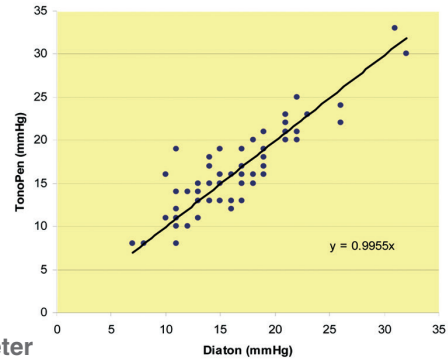
- We looked at 74 eyes of 38 consecutive patients who received both Tonopen and Diaton tonometry.
- TonoPen measurements were taken in the sitting position following topical anesthesia with proparicaine.
- Diaton measurements were performed in the sitting position with the patient gazing at a 45° angle, placing the eyelid margin at the superior limbus. If necessary, gentle traction was placed on the brow to align the lid with the limbus. The device was activated when the signaling mechanism indicated the device was vertical.

RESULTS

- Age range 3-91 years of age (mean 47.5 years).
- The average IOP with the Diaton was 16.24 (+/-5.11 mm Hg; range = 7-32mm Hg).
- The average IOP with the TonoPen was 16.37 (+/-4.90 mm Hg; range = 8-33 mm Hg).
- The mean variation between the two modalities was 1.59 mmHg (+/-1.31 mmHg; range = 0-6 mmHg).
- Eighty-one percent of all measurements were within 2 mmHg of each other (Table 1).
- There was no statistically significant difference in mean IOP values obtained with the two devices (p=0.87).

Table 1

Device	Mean IOP (standard deviation)	IOP Range
Tonopen	16.37 (+/-4.90 mm Hg)	8-33 mm Hg
Diaton	16.24 (+/-5.11 mm Hg)	7-32 mm Hg
Variance between devices	1.59 (+/-1.31 mm Hg)	0-6 mm Hg



Compasion of Diaton Tonometr to TonoPen Tonometer

CONCLUSIONS

- The Diaton tonometer pressure measurements correlated well with TonoPen measurements in this retrospective review.
- We did not find problems performing the exam in children, and many were reassured by the fact that no drops were needed.
- There may be a notable benefit in patients after refractive surgery or with corneal pathology since the Diaton does not applanate the cornea.
- The Diaton tonometer appears to be a clinically useful device in the IOP measurement of both children and adults.

Clinical comparison of the Diaton and the Non-contact Tonometers with the Goldmann applanation tonometer in glaucoma patients

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ESCRS, 2007

PURPOSE

Study of intraocular pressure evaluation (IOP) reliability using non-invasive devices, which require no anesthesia: transpalpebral scleral Diaton tonometer and non-contact pneumotonometer (NCT).

METHODS

Here the prospective comparative case series clinical study is presented.

87 patients (146 eyes) suffered from glaucoma (m:f = 51:36; age distribution: 29-85 years) were examined. For comparison IOP values received with Goldmann applanation tonometer (GAT) using the traditional methodology and digital mean values received with Diaton and NTC were used.

RESULTS

Mean IOP was 17,4±7,6 mmHg with GAT, 16,7±5,58 mmHg with Diaton, 21,4±9,13 mmHg with NCT. Minimum IOP value was 6,0 mmHg with GAT, 6,0 mmHg with Diaton, 5,0 mmHg with NCT; maximum value was 40,0 mmHg with GAT, 36,0 mmHg with Diaton, 47,0 mmHg with NCT. There was no significant difference of IOP values ($t = -0,51$, $p < 0,001$). The Pearson's correlation coefficient

was r=0.89, p<0,001 between GAT and Diaton; r=0,87,p<0,001 between GAT and NCT. There was observed high correlation of both tonometers with GAT in IOP range up to 30 mm Hg. In case of IOP significant increase NCT showed IOP overestimation up to 7 mmHg; Diaton showed IOP underestimation up to 4 mmHg.

CONCLUSIONS

The study shows high reliability of transpalpebral scleral Diaton tonometer enough for clinical purpose. It has both accuracy correlating with GAT and NCT's safety and operating speed. Diaton advantage is the possibility to evaluate IOP in cornea pathology, which is very important in glaucoma patients after corneal including laser surgeries.

Clinical use of transpalpebral scleral diaton tonometer in pediatrics

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2005

PURPOSE

Study of possibility of use and evaluation of transpalpebral scleral DIATON tonometer clinical use effectiveness in pediatrics.

METHODS

The prospective comparative case series clinical study was done in 60 children (120 eyes), age distribution 7-16 years. Existence of eyelids inflammatory diseases, their deformation, cornea pathology were exclusion criteria. During the study Goldmann tonometer and transpalpebral scleral DIATON tonometer were used. Intraocular pressure measuring was realized with three different DIATONdevices at the same day time. Researchers' experience of DIATON tonometery application in clinical practice was not less than 1 month.

RESULTS

For OD mean modified tonometry value with Golmann was 19,98±0,4 mmHg, mean IOP value measured with DIATON was 19,40±0,47 mmHg (t=0,65, df = 117, p> 0.05), for OS mean modified tonometry value with Golmann was 19,39±0,48 mmHg, mean IOP value with DIATON was 19,41±0,42 mmHg (t=0.99, df = 117, p> 0.05).

CONCLUSIONS

Clinical study of possibility of transpalpebral scleral DIATON application in children tonometer demonstrated its high accuracy. The recommended child's age for IOP measuring with this tonometer is 7-16 years. The advantages are: simplicity of use without any additional medicines, psychological acceptability by children, significant time saving for ophthalmotonometry procedure.

CONTENT

Dear professionals,

we appreciate your time and interest the new method of IOP measuring – diaton tonometry.

We hope present edition of collected articles helped you to get initial overview of diaton tonometer and to value its medical and clinical opportunities.

Thank you for attention!

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