THE COMBINED IOP AND CCT MEASUREMENT IN GLAUCOMA SCREENING

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RÉSUMÉ:

Dans une étude prospective nous avons mesuré la tension intra-oculaire à l'aide d'un pneumotonomètre et l'épaisseur centrale de la cornée dans 245 yeux emmétropes ou amétropes. Il y a une relation linéaire entre la tonométrie et la pachymétrie. Nous avons également examiné 30 yeux atteints de glaucome et de 16 yeux avec une hypertension oculaire. Les yeux normaux et les yeux glaucomateux montrent une même épaisseur moyenne de 554 μ.
Les yeux avec hypertension oculaire ont une épaisseur plus élevée.

MOTS CLÉS

Tonométrie, pachymétrie, hypertension oculaire, dépistage du glaucome.

SUMMARY

In a prospective study we measure the intra-ocular pressure (IOP) by means of a pneumotonometer and the central corneal thickness (CCT) in 245 healthy emmetropic or ametropic eyes consulting in a private practice. There is a linear relation between IOP measurement and CCT. The same measurements are done in 30 glaucomatous eyes and in 16 eyes with ocular hypertension. The mean CCT is similar in normal and glaucomatous eyes (554 μ). In eyes with ocular hypertension there is a manifest elevated CCT.

KEY WORDS

Tonometry, pachymetry, ocular hypertension, glaucoma screening.

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INTRODUCTION

Increased IOP is considered the main risk factor for glaucoma. The most exact technique to measure IOP is direct cannulation of the anterior chamber with a needle connected to a manometer.
Such a procedure is only possible in animals for experimental investigation.
In humans only a non invasive device can be used defined as tonometry. This involves applying a force against the cornea that produces a distortion of the globe.
Two types of tonometers are most currently used: the Goldmann tonometer and the non-contact pneumotonometer. Both systems work according the Imbert-Fick law. This law states that when a flat surface is pressed against a spherical surface of a container with a given pressure, an equilibrium will be attained when the force exerted is balanced by the internal pressure of the sphere exerted over the area of contact. Nevertheless this law has to be corrected because the cornea offers resistance to indentation varying perhaps with curvature and thickness.
Earlier studies of Ehlers et al (4) revealed that a true IOP of 20 mm Hg tonometry could underestimate the IOP by -5,2 mm Hg or overestimate it by 4,7 mm Hg, depending on the corneal thickness. At that time only an optical pachymeter was available and there was a lack of accuracy of this measurement.
Electronic pachymetry became popular since the start of the refractive surgery. Corneal thickness is important to evaluate the depth of the cuts in radial keratotomy and to limit the stromal ablation in lasik. This examination staid for long in the hands of refractive surgeons and didn't reach the level of routine examination in a common ophthalmological practice.
The mean purpose of this study is to investigate the difference in CCT in healthy people and the accuracy of IOP measurement with the pneumotonometer. This examination is after all routinely done for glaucoma screening.

SUBJECTS AND METHODS

We measured the intra-ocular pressure by means of a non-contact tonometer (Kowa TM 2000) and the central corneal thickness by an electronical pachymeter (Ophthasonic Teknar) in three groups of patients. The IOP value was the mean of 3 consecutive measurements.The first group consists of 245 healthy eyes (ametropic or emmetopic) with no evidence of glaucoma, the second group includes 30 glaucomatous eyes and the third group 16 eyes with ocular hypertension.

RESULTS

In a first series we did a combined tonometry and pachymetry on 245 eyes:

mean IOP:	16 mm Hg	mean pachy:	554 μ
std dev:	3,2	std dev:	38,36
min IOP:	10 mm Hg	min pachy:	415 μ
max IOP:	25 mm Hg	max pachy:	640 μ

In a second series we did the same examinations in 30 glaucomatous eyes (visual field defects and glaucomatous excavation), the IOP was measured before treatment:

mean IOP:	27,3 mm Hg	mean pachy:	554 μ
std dev:	4	std dev:	35
min IOP:	22 mm Hg	min pachy:	490 μ
max IOP:	37 mm Hg	max pachy:	620 μ

In a third series we did the same examinations in 16 eyes with ocular hypertension (no visual defects and no glaucomatous excavation):

mean IOP:	25 mm Hg	mean pachy:	613,4 μ
std dev:	2,17	std dev:	26,88
min IOP:	22 mm Hg	min pachy:	570 μ
max IOP:	29 mm Hg	max pachy:	660 μ

The mean CCT in normal eyes is 554 μ ±38,36. The regression equation for this group is calculated as $Y=0,045\ X\ -8,00$**.** The regression equation gives the relationship between CCT and IOP measurement (Y= IOP measurement in mm Hg and X = CCT in micron). The mean absolute error (mean of absolute error between the measured IOP and the calculated IOP with regression equation) is 2,16 ±1,6 with a maximum absolute error of 7,26. This maximal error can be due to a measurement error.
In 52 % of the analysed patients the regression line gives an approximation with an absolute error smaller than 2 mm Hg.

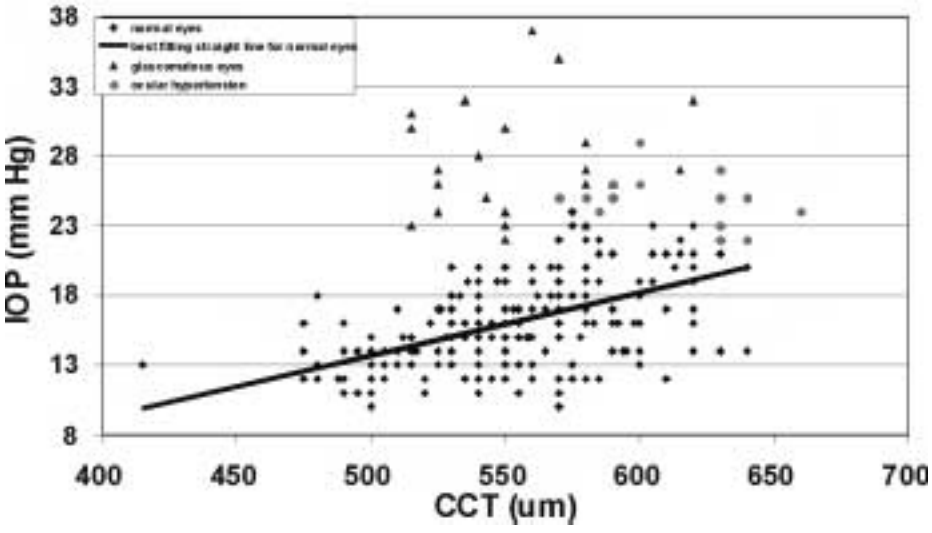
The correlation coefficient is *0,54.* It shows that the use of the regression line as an approximation of the relationship between IOP measurement and CCT is useful.

DISCUSSION

Since we started 4 years ago the myopic lasik technique we found after each procedure a lowering of the IOP. In a study of 172 eyes undergoing this technique for myopia (1) we found a mean lowering of IOP of 4,3 mm Hg with standard deviation of 2 for a mean stromal ablation of 74,6 μ with standarddeviation of 34,5.The statistical analysis of this study offers only a tendency of linear relation between the lowering of IOP and the amount of stromal thinning. Here we measured the IOP and the CCT in a non selected group of 245 eyes. To find a mathematical function that models the relationship between the IOP and the CCT, we calculated the ''best fitting curve'' through all the measurements points of this group. As the graphical analysis of the results didn't show any straightforward mathematical relationship, a rule of thumb for the relationship can be found by calculating the 'best fitting straight line': the ''regression equation''. The resulting regression line is: Y=0.045*X-8.00.

Let us write the regression equation for two patients: one ''normal'' with CCT 554 and one with a large CCT = CCT measured.
IOP normal =0.045*CCT normal - 8.00 and IOP measured=0.045*CCT measured - 8.00
Subtracting the second equation from the first gives us:
IOP normal - IOP measured=0.045*(CCT normal - CCT measured). CCT normal is 554 μ and IOP normal is the corrected IOP we are looking for = the IOP we would measure if the patient had a CCT of 554 μ. This gives us the equation we are looking for: IOP corrected = IOP measured + 0.045 * (554μ-CCT measured).
We know that the diagnosis of POAG is made on 3 diagnostic tools: visual field, cup/ disc ratio and tonometry. It is accepted that tonometry is the least accurate examination of these three but still most of the ophthalmologists, optometrists and even general practitioners use it as a first diagnostic tool.
In glaucoma screening and in glaucoma follow-up attention has to be paid to central pachymetry since the value of the IOP measurement is related to the central corneal thickness. Glaucoma screening and follow-up are more accurate with the combined measurement and the use of a CCT correction factor wil prevent the misdiagnosis of ocular hypertension and nor-

Relastionship between IOP and CCT for normal eyes, glaucomatous eyes and eyes with ocular hypertension



motensive glaucoma. We state that an electronic pachymeter should be a standard instrument in each glaucoma department.

CONCLUSION

1. There is no difference in CCT between normal and glaucomatous eyes. The mean CCT is 554 μ.
2. In non glaucomatous eyes there is a linear relation between IOP measured by pneumotonometry and CCT. As correction factor we propose: *corrected IOP = pneumotono-0,045 * (pachy - 554).*
   Further studies have to confirm this correction factor.
3. In eyes with ocular hypertension there is a manifest elevated CCT.

REFERENCES

(1) BURVENICH H., SALLET G., DE CLERCQ J. – The correlation between IOP measurement, central corneal thickness and corneal curvature. Bull Soc belge Ophtalmol, 2000, 276.

(2) BRON AM., CREUZOT GARCHER C., GOUDEAU BOUTILLON S., DATHIS P. – Falsely elevated intraocular pressure due to increased central corneal thickness. Graefes Arch Clin Exp Ophthalmol, 1999, 237, 220-224.

(3) COPT RP., THOMAS R., MERMOUD A. – Corneal thickness in ocular hypertension, primary open-angle glaucoma, and normal tension glaucoma. Arch Ophthalmol, 1999, 117, 14-16.

(4) EHLERS N., BRAMSEN T., SPERLING S. – Applanation tonometry and central corneal thickness. Acta Ophthalmol 1975;53:34-43.

(5) HERNDON LW., CHOUDRI SA., COX T., DAMJI KF., SHIELDS MB., ALLINGHAM RR. – Central Corneal Thickness in normal, glaucomatous, and ocular hypertensive eyes. Arch Ophthalmol, 1997, 115, 1137-1141.

(6) WHITACRE M., STEIN R. – Sources of error with use of Goldmann-type tonometers. Surv Ophthalmol, 38, 1-30.

(7) WOLFS RC., KLAVER CC., VINGERLING JR., GROBBEE DE., HOFMAN A., DE JONG PT. – Distribution of central corneal thickness and its association with intra-ocular pressure: The Rotterdam Study. Am J Ophthalmol, 1997, 123, 767-772.

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