THE CORRELATION BETWEEN IOP MEASUREMENT, CENTRAL CORNEAL THICKNESS AND CORNEAL CURVATURE

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RÉSUMÉ

Dans une étude prospective nous avons mesuré la pression intraoculaire, l'épaisseur centrale de la cornée et la courbure antérieure centrale de la cornée avant et après une intervention LASIK dans 172 yeux myopes. Il y a une forte baisse de la pression intraoculaire. L'évaluation statistique montre une corrélation linéaire entre la baisse de la pression et l'épaisseur du stroma.
La tension intraoculaire et la kératométrie ont été mesurés sur 21 yeux hypermétropes avant et après une intervention de LASIK. La pression intrao-culaire ne change pas.
Dans une étude rétrospective de 47 yeux atteints de myopie nous ne trouvons pas de changement de la tension intra-oculaire après une intervention de kératotomie radiaire.

SUMMARY

In a prospective study we measured the intraocular pressure (IOP), the central corneal thickness (CCT) and the central corneal curvature in 172 myopic eyes before and after LASIK treatment. We find a significant decrease in intraocular pressure. Statistical evaluation reveals a linear correlation between the IOP decrease and the amount of stromal ablation. The IOP and corneal curvature are measured in 21 hyperopic eyes before and after LASIK treatment. We do not find a change in the IOP. In a retrospective study of 47 myopic eyes before and after RADIAL KERATOTOMY we find no change in IOP. We conclude that CCT is important in evaluating the IOP and that corneal curvature has little effect on IOP measurement.

MOTS CLÉS

Tonométrie, pachymétrie, courbure corneénne, LASIK, kératotomie radiaire.

KEY WORDS

Tonometry, pachymetry, corneal curvature, LASIK, radial keratotomy.

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INTRODUCTION

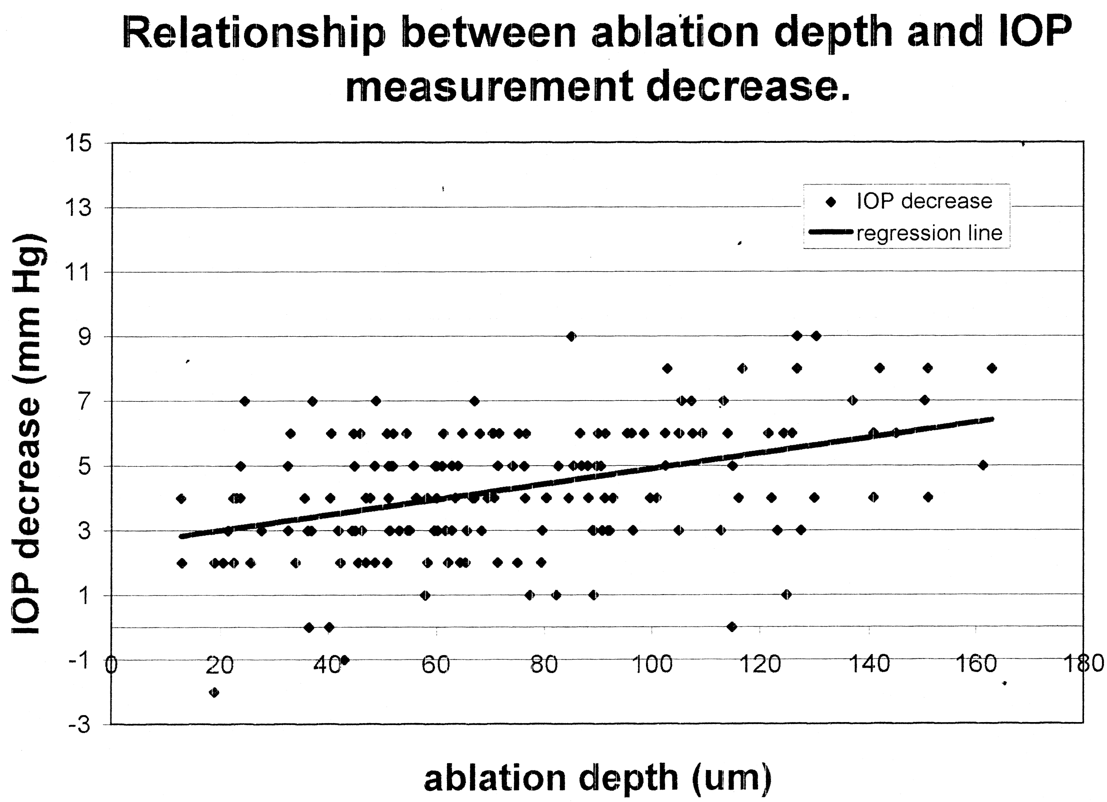
Many studies indicate that non-contact tonometry is a reliable and accurate technique to measure the IOP. It is demonstrated that the non-contact tonometer is accurate when compared to the Goldmann tonometer. Both systems work following the Imbert-Fick law.

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 none of the assumptions of this law is true. The cornea offers resistance to indentation, possibly varying with curvature and thickness.

Ehlers et al (3) performed simultaneous manometry and tonometry on 29 eyes about to undergo cataract or glaucoma surgery. The readings were evaluated in relation to the corneal thickness, corneal radius and the difference between the actual IOP and the indicated IOP. They found a systematic error in the accuracy of applanation tonometry, proportional to the real IOP and the central corneal thickness. In the studied population they interpolated that at a real 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. They calculated that the Goldmann tonometer gave accurate readings when the central corneal thickness was 0,52 mm.

In 1973 Mark (6)performed applanation tonometry and keratometry on 400 eyes and found that the mean IOP had a positive correlation with increasing corneal curvature, each diopter of corneal curvature being associated with an increase in measured intra-ocular pressure of 0,34 mm Hg. Over the studied range of 40-49 diopters of corneal curvature, he believed that corneal curvature was responsible for a 3 mm Hg variation in the tonometer readings.

Refractive procedures change corneal curvature and corneal thickness. It is interesting to



investigate how these procedures can change the IOP readings.

SUBJECTS AND METHODS

We measured the intra-ocular presssure by means of a non-contact tonometer (Kowa TM 2000), and the corneal curvature by an corneal topographe (Eyesys) in three groups of patients before and after refractive treatment. The IOP value before treatment was the mean of 3 consecutive measurements.The first group consists of 47 myopic eyes treated with radial keratotomy, the second group include 21 hyperopic eyes treated with the LASIK technique (NIDEK excimer laser) and the third group 172 myopic eyes treated with the LASIK technique (NIDEK excimer laser). In this third group central corneal thickness was measured by means of an electronic pachymeter (Teknar). After treatment we tried to measure the IOP at the same moment of the day to avoid the known diurnal variation. In the first group the IOP measurement was taken after a sometimes long period of corticosteriod treatment. In the LASIK groups local corticosteroids are given for only two days and the IOP meaurements are done more than 2 weeks after the LASIK intervention.

RESULTS

In the first group of 47 RK eyes we find a mean IOP before treatment of 17 mm Hg ±2,66 and a mean IOP after treatment of 17,2 mm Hg ±2,7. This is a mean IOP change of -0,2 ±2,87 with a max IOP change of +8 and a min IOP change of -6.The mean curvature pre is 44 D ±1,5 and the mean curvature post is 40,3 D ±1,6. The mean curvature difference is 3,54 D ±1,5. The peculiar extremes of IOP change can be due to not making allowance for diurnal variation of the pressure and the longterm influence of local corticosteroids. The conclusion is that we don't find IOP change in a small RK group before and after the treatment. In this group corneal curvature changes and it is assumed that CCT doesn't alter.

In the second small group of 21 eyes with hyperopic LASIK we find a mean IOP before treatment of 15 mm Hg ±3 and a mean IOP after treatment of 14 mm Hg ±2,8. The mean IOP change is 1,86 mm Hg ±1,9. The mean curvature before treatment is 43,6D ±1 and after treatment 46,2D ±2. The mean curvature change is 2,58 D ±1,3. The IOP change of 1,86 mm Hg is too small to draw conclusions since we have IOP decrease as well as IOP increase. We conclude that there is no IOP variation in a small hyperopic LASIK group before and after treatment. In this group the corneal curvature changes and it is assumed that CCT doesn't. The surgical act of LASIK itself, as told by others, has no effect on the tonometry readings.

In the third group of 172 eyes with myopic LASIK we find a mean IOP of 15,5 mm Hg +/- 2,72 before treatment and a mean IOP after treatment of 11,23 mm Hg ±2,45. There is a mean IOP decrease of 4,3 mm Hg ±2. The mean CCT before treatment is 548 μ ±36,5 and the mean ablation amount is 74,6 μ ±23,5. The regression equation is Y=0,024*X+2,52 for Y= IOP decrease and X= stromal ablation-depth. The correlation coefficient is 0,41. The mean of absolute error between a measured IOP decrease and a calculated IOP decrease is 1,54 mm Hg ±1,07.

DISCUSSION

It is known that IOP has a diurnal curve and that tonometry can present several causes of error. It can be possible that the measurements of very low IOP are less accurate than the measurements of fysiological IOP due to calibration of the instruments. Post myopic LASIK patients have sometimes very thin corneas. In the early days such thin corneas were exceptional and thickness was measured by mean of an optical system with a lower accuracy than the modern electronical instruments. The regression line gives us a relationship between the IOP decrease and the ablation depth.

IOP before treatment - IOP after treatment =0.024 * (ablation depth) + 2.52.

IOP before treatment = IOP after treatment + 0.024 *(ablation depth) + 2.52

Our statistical analysis offers only a tendency.The tangent of the regression line is small (0,024). It results in a flat line with a range in

IOP variation of 4 mm Hg. The mean error of 1,45 mm Hg and the maximum error of 5,26 mm Hg are too high to speak about a clearly linear course. The formula of the regression line is only a rule of thumb. The formula causes an error of more than 2 mm Hg for 24 % eyes and an error of more than 4 mm Hg for 3,5 % eyes. However this formula, that can only be used if we know the ablation depth, is comparable with the formula found in another study on IOP and CCT in healthy eyes without refractive surgery (1). As a rule of thumb we can use this second formula when the ablation depth is not known.

CONCLUSION

We state that the change in corneal curvature without change in CCT does'nt cause a significant IOP measurement change as we see after radial keratotomy and hyperopic LASIK. We state also that the decrease in CCT causes a significant decrease in tonometry after myopic LASIK intervention. There is a linear correlation between IOP measurement lowering and ablation depth, but our statistical analysis can only suggest it as a rule of thumb.

In the growing population of LASIK patients the estimation of the IOP should be related to the ablation depth.

Further studies on larger numbers have to confirm these results.

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