

Corneal hysteresis and primary open angle glaucoma

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Abstract

Objects: To investigate the variability of the corneal hysteresis in primary open angle glaucoma(POAG) patients.

Material and Methods: Out of 123 eyes, 99 carried out the inclusion criteria and were investigated further using Goldman Aplanotonometer to measure intraocular pressure(IOP), Ocular Response Analyzer(ORA) in order to determine corneal hysteresis (CH) and corneal resistance factor(CRF), ultrasonic pachimetry (Ocuscan) to measure central corneal thickness(CCT) and Humphrey visual field to determine mean deviation(MD), pattern standard deviation(PSD) and visual field index(VFI). The patients were divided into two groups: one group of diagnosed POAG patients and one control group of healthy individuals. Statistical analysis was performed using descriptive analyses and linear regression.

Results: A considerable statistic correlation was found between CH and VFI both in the group of primary open angle glaucoma patients($r=0.52$, $P<0.0001$), and the control group ($r=0.22$, $p<0.04$).

Conclusions: The study shows a positive correlation, statistically significant, between corneal hysteresis and visual field index both in glaucoma patients and control subjects proving that a lower CH associates with a lower VFI. Ocular response analyzer can be considered a useful instrument in evaluation of primary open angle glaucoma patients.

Key words: glaucoma, hysteresis, cornea

Introduction

Glaucoma represents the second leading cause of blindness in the world [1] determining progressive visual field damage associated with variable optic nerve head changes [2].

Cornea is known as a viscoelastic system that can be defined through its physical dimensions (central corneal thickness (CCT)) and behavior (biomechanics) [6]. Studies such as Ocular Hypertension Treatment Study show that

CCT represent a risk factor for the progression of glaucoma progression independent on the IOP [7].

Corneal hysteresis (CH) does not represent an intrinsic corneal property, it measures the ability of the cornea to absorb and dissipate energy [6]. In this way, CH can help physicians predict how the eyes will react to high intraocular pressure (IOP) and which eyes are more susceptible to optic nerve head damage and visual field loss.

Key words: glaucoma, hysteresis, risk, progression

Objectives

To investigate the role of corneal hysteresis in primary open angle glaucoma (POAG) patients and to find a way to identify those patients that have a higher risk of glaucoma progression over time.

Materials and Methods

This was an observational study that included 99 eyes that were divided into two groups: first group contains 37 eyes diagnosed primary open angle glaucoma while the second group contains 21 healthy eyes.

All patients underwent a complete ophthalmologic examination which included anamnesis, visual acuity measurement with and without correction, slit lamp examination of the anterior pole, intraocular pressure measurement using Goldman aplanotonometer, gonioscopic examination, computerized perimetry using Humphrey perimeter strategy 24-2 followed by Ocular Response Analyzer measurement, ultrasonic pachimetry, instillation of mydriatics and fundus examination.

For statistical analysis we used descriptive analysis and frequency tests, means and linear regression.

Results

The means of IOP in the first group was 19mmHg \pm 5.31mmHg, while in the second group was 17mmHg \pm 2.97mmHg. Means of CH was 9.85 \pm 1.96 in POAG group and 11.0 \pm 1.51 in the control group, while means of CRF was 10.3 \pm 1.77 in the first group and 11.6 \pm 1.65 in second group. Means of CCT was 547 μ \pm 39.55 μ in POAG group and 575 μ \pm 39.80 μ in the control group.

A considerable negative statistic correlation was found between CH and IOP both in the group of primary open angle glaucoma eyes ($r=-0.27$, $p<0.0001$) (**Fig. 1**), and the control group ($r=-0.53$, $p<0.0001$). The correlation between CH and CCT was a positive

one ($r=0.38$, $p<0.0001$) for the first group and the second group ($r=0.39$, $p<0.02$). Corneal hysteresis also correlates positively with mean deviation ($p=0.63$, $p<0.0001$) and ($p=0.67$, $p<0.0001$) respectively. Correlation between corneal hysteresis and visual field index is also positive in both groups: ($r=0.52$, $P<0.0001$) for POAG group (**Fig. 2**) and ($r=0.22$, $p<0.04$) for the control group.

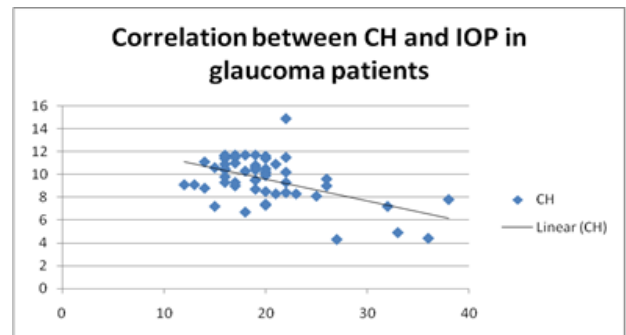


Fig. 1. Linear regression analysis showing a negative correlation between CH and IOP in POAG patients

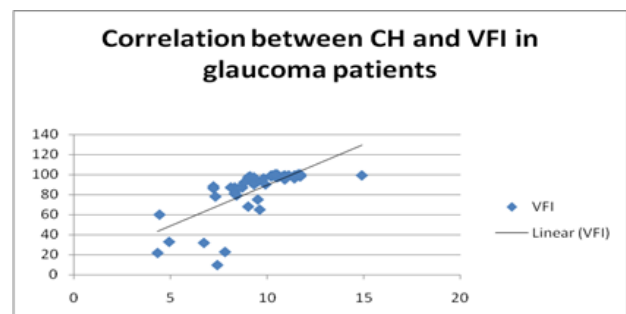


Fig. 2. Linear regression analysis showing a positive correlation between CH and VFI in POAG patients

Discussions

There are many studies which clarify the implication of the central corneal thickness in primary open angle glaucoma. Although in the past it was considered that the progression and the prognosis of the glaucoma are influenced by CCT, recent studies centered on the involvement of the biomechanical properties showed that a low corneal hysteresis represents a risk factor in

glaucoma progression and in the advancement of the visual field deficit, no matter the central corneal thickness [9-12]. According to our study, corneal hysteresis and corneal resistance factor are considerably lower in primary open angle glaucomatous eyes than in healthy eyes. Central corneal thickness is also smaller in the first of the two groups.

Like the data already presented in literature our research shows a positive statistically significant correlation, both between the corneal hysteresis and visual field parameters MD and VFI measured with the Humphrey perimeter. This correlation indicates that those eyes that have lower corneal hysteresis have higher risk of visual field loss due to glaucoma.

Conclusions

It is already known that a thin cornea represents a risk factor in glaucomatous eyes, thus, the positive correlations found between CH and CCT and between CH and VFI show once again the importance of corneal biomechanics in diagnosis and follow up of angle glaucoma patients.

References

1. <http://www.who.int/bulletin/volumes/82/11/feature1104/en/>.
2. Manosiri K, Leite NT, Weinreb RN. Association between Corneal Biomechanical Properties and Glaucoma Severity, *Am J Ophthalmol*. 2012 Mar;153(3):419-427.e1. doi: 10.1016/j.ajo.2011.08.022. Epub 2011 Oct 21.
3. Gordon MO, Beiser JA, Brandt JD, et al. The Ocular Hypertension Treatment Study: baseline factors that predict the onset of primary open-angle glaucoma. *Arch Ophthalmol*. 2002;120(6):714-20. discussion 829-30.
4. Leske MC, Heijl A, Hyman L, et al. Predictors of long-term progression in the early manifest glaucoma trial. *Ophthalmology*. 2007;114(11):1965-72.
5. Herndon LW, Weizer JS, Stinnett SS. Central corneal thickness as a risk factor for advanced glaucoma damage. *Arch Ophthalmol*. 2004;122(1):17-21.
6. Madhvi Deol, David Taylor, Nathan Radcliffe, Corneal hysteresis and its relevance to glaucoma. *Curr Opin Ophthalmol*. 2015 Mar; 26(2): 96-102.
7. Naim Terai, Frederik Raiskup, Eberhard Spoer. Identification of Biomechanical Properties of the Cornea: The Ocular Response Analyzer. *Curr Eye Res* 2012 Jul;37(7):553-62. doi: 10.3109/02713683.2012.669007.
8. Nathan Radcliffe. Hysteresis: a powerful tool for glaucoma care. *Glaucoma management, Review of Ophthalmology*; Jan 2014, Vol. 21 Issue 1, p50.
9. Tsikripis P1, Papaconstantinou D, Koutsandrea C, Apostolopoulos M, Georgalas I. The effect of prostaglandin analogs on the biomechanical properties and central thickness of the cornea of patients with open-angle glaucoma: a 3-year study on 108 eyes. *Drug Des Devel Ther*. 2013 Oct 4;7:1149-56. doi: 10.2147/DDDT.S50622. eCollection 2013.
10. Wells AP, Garway-Heath DF, Poostchi A, Wong T, Chan KC, Sachdev N. Corneal hysteresis but not corneal thickness correlates with optic nerve surface compliance in glaucoma patients. *Invest Ophthalmol Vis Sci*. 2008;49:3262-3268. [PubMed].
11. Gordon MO, Beiser JA, Brandt JD, et al. The Ocular Hypertension Treatment Study: baseline factors that predict the onset of primary open-angle glaucoma. *Arch Ophthalmol*. 2002;120:714-720. [PubMed].
12. Bochmann F, Ang GS, Azuara-Blanco A. Lower corneal hysteresis in glaucoma patients with acquired pit of the optic nerve (APON) *Graefes Arch Clin Exp Ophthalmol*. 2008;246:735-738. [PubMed].