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Relevancy of corneal biomechanical in glaucoma

Relevância da biomecânica da córnea no glaucoma

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ABSTRACT

Case report of a patient, with a thick cornea, for Fuchs dystrophy in its early stages, yet with preserved corneal transparency (subclinical corneal edema), associated with normal intraocular pressure (IOP) by Goldman applanation tonometry (GAT), which was however, the diagnosis of primary open-angle glaucoma on the basis of structural changes of the optic nerve. The tomographic study showed a pattern of spatial pachymetry compatible with subclinical edema. The corneal biomechanical study with ORA (Ocular Response Analyzer, Reichert ®) associated with corrected IOP measurement, allowed the understanding of the corneal influence, which, although thicker, leading to a falsely low TAG (underestimated). The IOP study with tonography system digital (PASCAL) corroborated with the findings of ORA. This example highlights the importance of new technologies in patients' evaluation with suspected glaucoma, and highlights that the correction of TAG, based on linear algorithms related to central corneal thickness alone, can determine serious errors in clinical interpretation.

Keywords: Cornea/physiology**;** Glaucoma; ORA; Fuchs endothelial dystrophy; Tonometry, ocular/methods; Case reports

RESUMO

Relato de caso de uma paciente, com córnea espessa, por distrofia de Fuchs em fase inicial, ainda com transparência corneana preservada (edema corneano subclínico), associado a pressão intra ocular (PIO) normal por tonometria de aplanação de Goldman (TAG), que teve entretanto, o diagnóstico de glaucoma primário de ângulo aberto com base em alterações estruturais do nervo óptico. O estudo tomográfico demonstrou padrão de paquimetria espacial compatível com edema sub-clínico. O estudo biomecânico da córnea com o ORA (Ocular Response Analyzer, ® Reichert), associado à medida corrigida da PIO, possibilitou o entendimento da influência da córnea, que apesar de mais espessa, levava a uma TAG falsamente reduzida (hipoestimada). O estudo da PIO com sistema de tonografia digital de contorno (PASCAL) corroborou com os achados do ORA. ***Este*** *exemplo ressalta a importância de novas tecnologias na avaliação de pacientes com suspeita de glaucoma, e destaca que a correção da TAG, com base em algoritmos lineares relacionados com a paquimetria central apenas, pode determinar sérios erros de interpretação clínica.*

Descritores: *Córnea/fisiologia; Glaucoma; ORA; Distrofia endotelial de Fuchs; Tonometria ocular/métodos; Relatos de casos*

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Introduction

Glaucoma is an optic neuropathy with characteristic lesions that cause specific visual field defects.[1,2] Increased intraocular pressure (IOP) is the most important risk factor and is also the focus of therapy aimed at controlling the disease.[3,4] Changes in corneal structure lead to changes in IOP values as measured by Goldmann applanation tonometry (GAT).[5,6] The cornea has therefore become the object of study in glaucomatous injury, mainly through central pachymetry, which measures central corneal thickness (CCT). According to Ambrósio, mean CCT in the population is 556 microns, with a standard deviation of 35 microns, ranging between 454 and 669 microns.[7] CCT has been shown to be the most important risk factor in patients with high IOP.[8] This is due to the fact that GAT tends to underestimate IOP in thin corneas; as a result, these patients may not receive treatment,[9,10] which increases the risk of progressive optic nerve cupping due to damage caused by the persistently elevated IOP.

The prediction model that combines data from the Ocular Hypertension Treatment Study (OHTS) and the European Glaucoma Prevention Study Group (EGPS) estimates that for a 40-micron decrease in CCT the risk of glaucomatous damage in five years is doubled.

Other corneal parameters, such as keratometry, also have an important influence on the error of IOP measurement by applanation, which is overestimated in thicker and steeper corneas. Given these facts, new parameters may be needed to better assess the cornea, which is a critical element in the follow-up of glaucoma patients.

Pachymetry is a key test in the evaluation of these patients, but its results can be misinterpreted when used alone; thus, new technologies such as the ORA (Ocular Response Analyzer, Reichert™) device need to be used.

The ORA is an air-puff tonometer that uses an air pulse whose intensity is very well controlled and monitored, with symmetrical upward and downward phases. The test takes about 20 milliseconds. The air pulse causes a deformation of the corneal surface, which first undergoes a moment of applanation, identified as a peak in the corneal reflex. The pressure then causes the cornea to become slightly concave, returning to its original state after undergoing a second stage of applanation (Figure 1). The behaviour of the cornea and the signal obtained during the test represent its biomechanical properties. The difference between pressures in the two applanation moments is related to the viscoelastic capacity of the cornea to store energy, called hysteresis.

Four parameters are obtained in the current version of the ORA software:[11]

- Goldman-correlated IOP (IOPg)
- Corneal-compensated IOP (IOPcc)
- Corneal hysteresis (CH)
- Corneal resistance factor (CRF)

. Stage 1: First corneal applanation
. Stage 2: Cornea becomes slightly concave
. Stage 3: Second corneal applanation

The method provides an assessment of biomechanical changes in the cornea, observed as a significant decrease in the cornea's viscoelastic ability to absorb energy from the symmetrical air pulse[11] (its upward phase is identical to its downward phase).

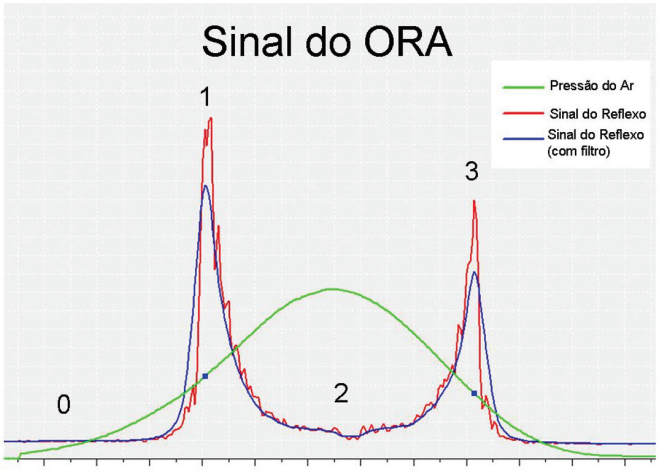

Figure 1. ORA signal

Case report

54-year-old white female housewife born in Rio de Janeiro with no pre-existing ocular disorders, undergoing treatment for high blood pressure with captopril 25 mg twice daily, complaining of reduced visual acuity in both eyes (BE), more severe on the right eye (RE). Her mother suffered from glaucoma. Ophthalmic examination showed an uncorrected visual acuity of 20/150 in BE and a corrected visual acuity of 20/40 and 20/30 (+1.75 = -0.50 x 90º - 20/40; +1.50 = -0.50 x 85º - 20/30).

GAT was 18 mmHg in the RE and 17 mmHg in the left eye (LE) at 5 pm. Slit lamp examination (biomicroscopy) showed transparent corneas in BE, with guttata 2+/4+ (Figure 2), grade 2 nuclear cataract, and mild posterior subcapsular cataract. On gonioscopy, open angle to the scleral spur in the four quadrants in BE. Perimetry showed a diffuse loss of sensitivity in BE without specific changes.

Central corneal thickness was measured by pachymetry, showing 620 microns in BE.[7] Non-contact air-puff tonometry (ORA), dynamic contour tonometry (DCT-Pascal™, Ziemer), and a tomography[12,13] of the cornea and anterior segment using Scheimpflug photography[13,14] were performed. The following values were found: CH, 7.9 and 8.1 mmHg (normal mean value, 10.17); IOPcc, 26.1 and 24.2 mmHg; IOPg, 18.1 and 17.9 mmHg; DCT-PASCAL: 27.2 and 26.5 mmHg. Tomography of the cornea and anterior segment showed a pattern compatible with subclinical oedema. This pattern occurs when the pachymetric progression profile is straightened or horizontal (Figure 3).[12] Simple retinography of the optic nerve showed increased and asymmetric cupping, 0.8 x 0.8 and 0.6 x 0.6 in the RE and LE, respectively. There were no changes in the macula, and the retina was attached in all quadrants.

Discussion

Since the publication of the OHTS study in 2002, CCT is known to be the most important predictive factor for the development of glaucoma in patients with high IOP. It is clear that IOP measurement is overestimated in thick corneas and underestimated in thin corneas.

However, thickened corneas due to oedema have a reduced resistance, producing an effect similar to thin corneas in GAT.[7]

Thus, it is clear that pachymetry remains very important for corneal assessment in glaucoma patients. However, when used

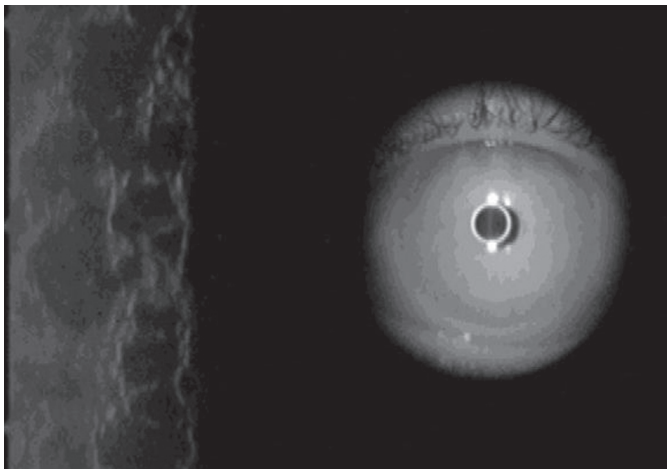

Figure 2. Specular microscopy

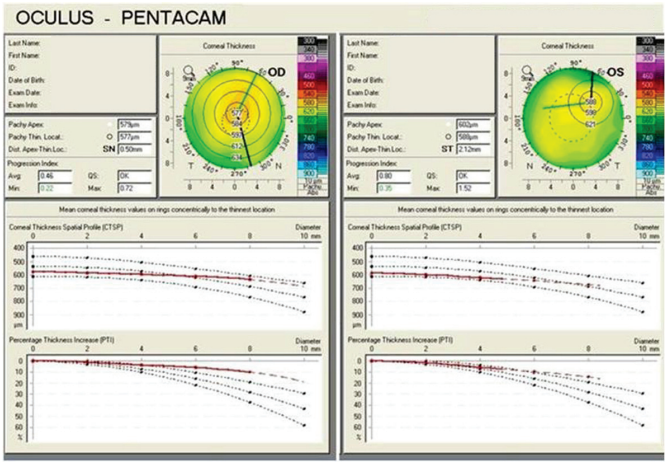

Figure 3. Spatial pachymetric progression curve[12] showing a straightened pattern

alone it can lead to diagnostic errors, hindering adequate disease management.

In the case presented here, evaluation of corneal biomechanics and computed tomography with ORA and Pentacam were essential for adequate assessment of a patient with corneal oedema due to Fuchs dystrophy. These tests revealed that the patient's IOP had been underestimated, which enabled adequate treatment and control.

It is important to note that in order to unequivocally determine which IOP measurement (GAT, ORA or PASCAL) was correct, it would be necessary to assess the pressure in the anterior chamber using a direct invasive method to measure hydrostatic pressure. However, this kind of procedure is clinically impractical.

Conclusion

The case presented here shows beyond any doubt that the cornea influences IOP measurements by GAT. However, such influence is more complex than anticipated by linear algorithms that consider central pachymetry only. In this case, a serious misinterpretation would occur if only GAT values and the relatively high central pachymetry were considered, because the elevated IOP would be missed. The diagnosis of glaucoma is based on optic nerve findings.

However, biomechanical studies and CT enabled a correct interpretation of the influence of the cornea on GAT, thus identifying the patient's ocular hypertension and diagnosing a primary open angle glaucoma (POAG). Such tests should be considered in the evaluation of patients with suspected glaucoma as well as during their clinical follow-up.

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