Kaohsiung Journal of Medical Sciences (2014) 30, 299–304

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://www.kjms-online.com

ORIGINAL ARTICLE

Corneal biomechanical properties in thyroid eye disease

Gamze Ozturk Karabulut [a,*], Pelin Kaynak [a], Cıgdem Altan [a], Can Ozturker [a], Ebru Funda Aksoy [a], Ahmet Demirok [b], Omer Faruk Yılmaz [a]

[a] *Beyoglu Eye Research and Training Hospital, Istanbul, Turkey*
[b] *Department of Ophthalmology, Medeniyet University, Istanbul, Turkey*

Received 18 June 2013; accepted 10 January 2014
Available online 17 April 2014

KEYWORDS
Corneal hysteresis;
Corneal biomechanical properties;
Thyroid eye disease;
VISA classification

Abstract The purpose of this study is to investigate the effect of thyroid eye disease (TED) on the measurement of corneal biomechanical properties and the relationship between these parameters and disease manifestations. A total of 54 eyes of 27 individuals with TED and 52 eyes of 30 healthy control participants were enrolled. Thyroid ophthalmopathy activity was defined using the VISA (vision, inflammation, strabismus, and appearance/exposure) classification for TED. The intraocular pressure (IOP) measurement with Goldmann applanation tonometer (GAT), axial length (AL), keratometry, and central corneal thickness (CCT) measurements were taken from each patient. Corneal biomechanical properties, including corneal hysteresis (CH) and corneal resistance factor (CRF) and noncontact IOP measurements, Goldmann-correlated IOP (IOP_g) and corneal-compensated IOP (IOP_{cc}) were measured with the Ocular Response Analyzer (ORA) using the standard technique. Parameters such as best corrected visual acuity, axial length, central corneal thickness, and corneal curvature were not statistically significant between the two groups ($p > 0.05$). IOP measured with GAT was higher in participants with TED ($p < 0.001$). The CH of TED patients was significantly lower than that of the control group. There was no significant difference in the corneal resistance factor between groups. However, IOP_g and IOP_{cc} were significantly higher in TED patients. CH and VISA grading of TED patients showed a negative correlation ($p = 0.007$). In conclusion, TED affects the corneal biomechanical properties by decreasing CH. IOP with GAT and IOPg is found to be increased in these patients. As the severity of TED increases, CH decreases in these patients.

Conflicts of interest: All authors declare no conflicts of interest.

* Corresponding author. Seyitnizam Mahallesi Balıklı Cırpıcı Yolu Sokak, Topkapı Merkez Evleri İkinci Etap, B-2 Blok Daire: 8, 34010 Zeytinburnu, Istanbul, Turkey.
E-mail address: gozturk2911@yahoo.com (G.O. Karabulut).

http://dx.doi.org/10.1016/j.kjms.2014.02.015

Introduction

Thyroid eye disease (TED) is an inflammatory and autoimmune expression of Graves' disease causing functional and cosmetic problems. The clinical manifestations of TED are periorbital edema, increase in orbital volume which may lead to increase in intraorbital pressure, conjunctival hyperemia and chemosis, proptosis, restrictive myopathy leading to strabismus and/or diplopia, eyelid retraction, exposure keratopathy, lagophthalmus, and compressive optic neuropathy [1,2].

The alterations in the ocular surface due to increased palpebral fissure width, increased blink rate, lagophthalmus, and lid lag in TED patients resulting in hyposecretory and evaporative mechanism, modify the tear film and leads to dry eye syndrome [3,4]. The increase in tear film osmolarity in patients with TED is also related to increased proptosis and palpebral fissure width [4—6]. Villani et al [3] demonstrated that the significant reduction in surface epithelial cell density is due to the damaged ocular surface, increase in the number of basal epithelial cells owing to a proliferative stimulus, and the increase in activated keratocytes and dendritic cells as a sign of inflammation with confocal microscopy in Graves' ophthalmopathy. They also showed that the number of nerves was reduced, and the tortuosity of the nerve fibers and the number of beadlike formations were increased.

The cornea is not purely elastic but rather viscoelastic, which means that the rate at which a load is applied changes the measured value for the Young modulus [7,8]. *In vivo* corneal biomechanical evaluation was first introduced by Luce [9] using the Ocular Response Analyzer (ORA; Reichert Ophthalmic Instruments, Depew, NY, USA). This instrument measures the corneal biomechanical properties as corneal hysteresis (CH) and corneal resistance factor (CRF), and determines the noncontact intraocular pressures (IOP) as Goldmann-correlated IOP (IOP_g) and corneal-compensated IOP (IOP_{cc}) [9—11]. The ORA evaluates corneal response to indentation by a rapid air pulse using an infrared light to measure applanation of the cornea. The air pulse results in an inward, and concave state of cornea. As the air pressure decreases, the cornea passes back through the applanation and moves outward. It provides two applanation measurements and pressures within 20 milliseconds: one when the cornea is flat on the way in (P1) and the other on the way out (P2) (Fig. 1) [12]. The difference between two pressures is CH, reflecting corneal viscoelasticity. CRF is calculated from the formula (P1 − *k*P2), where *k* is a constant. The constant *k* is determined from an empirical analysis of the relationship between both P1 and P2 and the central corneal thickness (CCT) to develop a parameter more strongly associated with CCT than CH [13]. CRF is thought to represent the overall resistance and the elastic properties of the cornea. IOP_g is the average of two pressure measurements, which is intended to correspond to the Goldmann applanation tonometer (GAT). IOP_{cc} is a pressure measurement that is said to be compensated for corneal properties, and uses information provided by CH measurement to obtain an IOP that is less affected by CCT and corneal curvature [8,9].

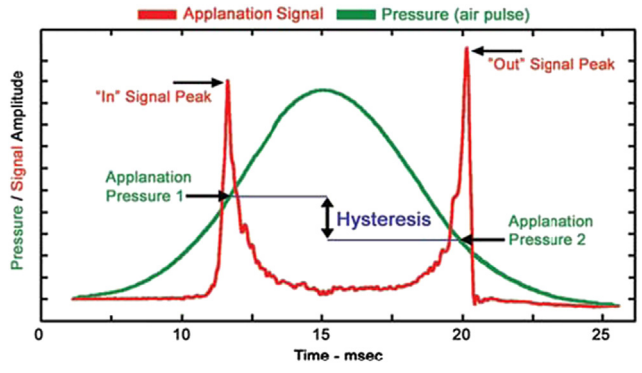

Figure 1. Corneal hysteresis is the difference between "inward" and "outward" applanation pressures.

In recent years, evidence suggests that the biomechanical properties of the cornea are altered in glaucomatous eyes [10,14—16], keratoconic corneas [17—19], myopic eyes [13,20,21], in eyes of individuals with diabetes mellitus [11,22] and systemic lupus erythematosus [23], in post-laser *in situ* keratomileusis eyes [24,25], and in eyes following penetrating keratoplasty [26]. The aim of this study was to investigate biomechanical parameters of the cornea measured with ORA in TED, and the relationship between these parameters and disease manifestations.

Methods

A total of 54 eyes of 27 patients who were admitted to the oculoplastic and reconstructive surgery department because of TED and 52 healthy eyes of 30 control individuals were enrolled in this observational comparative study in Beyoglu Eye Training and Research Hospital, Istanbul, Turkey between January 2011 and June 2011. Informed consent was obtained from all participants. The study followed the tenets of the Declaration of Helsinki and was approved by the local ethics committee.

Exclusion criteria consisted of glaucoma, diabetes, history of ocular surgery or trauma, use of any topical medication, contact lens wear, and high refractive error or corneal abnormalities such as keratoconus and corneal dystrophy, which may affect measurement.

Diagnosis of TED was based on the criteria of the European Group on Graves' Orbitopathy Consensus Statement [27,28]. Thyroid ophthalmopathy activity was defined by using the VISA classification for TED [29]. This classification system is based on four disease end points: vision, inflammation, strabismus, and appearance/exposure. Each section records subjective and measurable objective inputs and plans ancillary testing. The goal of the vision section is described as to rule out optic neuropathy. Details on vision loss and color change were asked from TED patients as subjective measurements. Best corrected visual acuity (BCVA; using Snellen chart), color vision (using Ishihara plates), pupil response, and the appearance of optic nerve head were used as objective tests for vision. Ancillary testing included Standard Automated Perimetry with the Humphrey Field Analyzer (Carl Zeiss Meditec, Dublin, CA, USA) using the 30-2 SITA Standard program as well as computed tomography or magnetic resonance imaging scans to confirm crowding of orbital apex and extraocular