Central Corneal Thickness in Patients With Neovascular Age-Related Macular Degeneration

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Purpose: To compare the central corneal thickness (CCT) measurements of patients with neovascular age-related macular degeneration (AMD) and control subjects.

Methods: The CCT value (measured with ultrasound corneal pachymetry) of 130 eyes (130 patients, 1 eye from each patient) with neovascular AMD (AMD group) and 98 eyes (98 patients, 1 eye from each patient) of similar age, sex, and eye's axial length healthy control subjects (normal group) was compared.

Results: The mean age (AMD group: 69.1 years vs. control group: 69.5 years, $P = 0.81$), sex (AMD group: 77 women, 59% vs. control group: 59 women, 60%, $P = 0.77$), and eye's axial length (AMD group: 25.05-mm vs. control group: 24.61-mm, $P = 0.38$) of patients with neovascular AMD and healthy control subjects were comparable. There were no statistically significant differences in the mean CCT measurements in the neovascular AMD group in comparison with the control group (549.44 vs. 544.35 μm, $P = 0.11$).

Conclusions: CCT measurements do not differ in patients with neovascular AMD compared with healthy control subjects.

Key Words: corneal thickness, neovascular, age-related macular degeneration

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Age-related macular degeneration (AMD) is the leading cause of blindness in the developed world.[1,2] The etiology of AMD is poorly understood, but it is most likely a complex disease in which several risk factors seem to have a potential role.[3] Smoking, hyperlipidemia, elevated blood pressure, and atherosclerosis and history of cardiovascular diseases are a few of the described risk factors that may contribute in the development of this disease.[4,5]

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Central corneal thickness (CCT) is of great significance clinically. It has been associated with several systemic ocular conditions such as active Behçet disease, Down syndrome, diabetes, osteogenesis imperfecta, keratoconus, dry eye, glaucoma, and retinal detachment.[6–13] It has been hypothesized that ocular factors, such as cataract extraction, iris color, refractive errors, and ocular rigidity, may also be involved in the development of AMD,[14,15] whereas there is a possible correlation between these factors and CCT (CCT contributes to the corneal rigidity that is 1 of the major components of ocular rigidity besides scleral rigidity). On the basis of these observations, we compared the CCT of patients with neovascular AMD and control subjects to study the possible association of CCT with AMD.

MATERIALS AND METHODS

Ninety-eight eyes of 98 healthy subjects (control group, 59 women, 60%) and 130 eyes of 130 patients previously diagnosed with AMD with choroidal neovascularization (AMD group: 77 women, 59%) were included in this prospective study. The institutional review board at the University of Crete approved the study protocol. All study procedures adhered to the Declaration of Helsinki for research involving human subjects. After informed consent was obtained, a complete ocular examination was performed.

The ophthalmic examination included a measurement of visual acuity, slit-lamp examination, measurement of CCT, indirect and direct ophthalmoscopy, and fundus photography. Exclusion criteria were the use of contact lens, any corneal pathology, eye drop users, dry eye symptoms, previous ophthalmic surgery (except photodynamic therapy for corneal neovascularization (CNV) patients), history of corneal disease, and ocular trauma. Patients were classified as having neovascular AMD on the basis of standard findings by clinical examination and fluorescein angiography. Neovascular AMD was defined as the presence of a serous or hemorrhagic neuroretinal or retinal pigment epithelium (RPE) detachment and/or a subretinal neovascular membrane and/or a subretinal hemorrhage and/or a periretinal fibrous scar. No distinction was made about the type or stage of CNV (ie, classic, occult, retinal angiomatous proliferation, or disciform scar formation). Patients may have undergone treatment of their CNV. Lesions that were considered to be the result of generalized disease, such as diabetic retinopathy, chorioretinitis, high myopia, trauma, congenital diseases, or photocoagulation for

reasons other than neovascular AMD, were excluded. The control group included patients who were examined for routine cataract extraction without evidence of drusen, pigmentary changes, CNV, or any other pathologic ocular condition (except cataract), whereas the AMD group included patients with neovascular AMD who were treated with photodynamic therapy.

CCT, in both healthy volunteers and AMD, was evaluated by the same experienced ophthalmologist (N.T.) with ultrasound pachymetry (DGH 5100 Technology, Exton, PA). Corneal thickness measurements were carried out from 10:00 AM to 12:00 AM to avoid the diurnal variation in corneal thickness values and before any invasive examination procedure (such as Goldmann tonometry). Corneal anesthesia was achieved using benoxinate 0.4% applied immediately before measurement. The probe tip of the pachymeter was held perpendicular to the cornea and centered over the pupil. Each patient was asked to blink before CCT measurements to avoid any bias because of corneal drying. Five consecutive measurements were made at the center of the cornea of each eye. The lowest CCT measurement was used in the statistical analysis because it was thought to most likely reflect a perpendicular placement of the pachymeter probe and therefore to be the most accurate measurement.

Unpaired Student *t* test was applied. *P* values less than 0.05 were considered to be statistically significant.

RESULTS

Table 1 presents the demographic, clinical, and ocular characteristics of the study cohort of study participants. The mean age in healthy subjects was 69.5 ± 9.7 (SD) years (range, 51–90 years) and was 69.1 ± 11.5 years (range, 44–83 years) in patients with AMD. There were no statistically significant differences in age between study groups ($P = 0.81$). Furthermore, the 2 study groups were comparable for sex (control group: 59 women, 60% vs. AMD group: 77 women, 59%, $P = 0.77$) and ocular axial length [control group: 24.61 ± 2.75 mm (range, 21.61–31.00 mm) vs. AMD group: 25.05 ± 2.78 mm (range, 22.06–31.02 mm); $P = 0.38$; Table 1]. The mean CCT measurements were not significantly different in the neovascular AMD group compared with the control group [549.44 ± 26.41 μm (range, 491–601 μm) vs. 544.35 ± 18.70 μm (range, 482–586 μm), respectively; $P = 0.11$; Table 1]. The mean difference [95% confidence interval (CI) of the difference] of CCT measurements between patients with AMD and the control group was 5.09 μm (95% CI, –1.23 to 11.41).

TABLE 1. Baseline Characteristics of the Study Participants

Characteristics	AMD Group (130 Patients)	Control Subjects (98 Patients)	*P*
Age (yr; mean ± SD)	69.1 ± 11.5	69.5 ± 9.7	0.81
Female [no. (%)]	77 (59%)	59 (60%)	0.77
Axial length (mm; mean ± SD)	25.05 ± 2.78	24.61 ± 2.75	0.38
CCT (μm; mean ± SD)	549.44 ± 26.41	544.35 ± 18.70	0.11

DISCUSSION

Corneal thickness could be representing a biomechanical parameter of the eye with several implications. An association between CCT and several clinical conditions has been documented (such as optic nerve drusen, pituitary adenoma, pregnancy, osteogenesis imperfecta, glaucoma, diabetes, and retinal detachment).[6–13,16]

Several ocular factors, such as cataract (extraction), iris color, refractive errors, and ocular rigidity, in addition to smoking, atherosclerosis, and genetic factors, may also be involved in the development of AMD.[1–5,14,15] The possible pathophysiologic mechanism by which corneal thickness may be implicated in the pathogenesis of choroidal neovascularization in AMD could be the correlation between corneal thickness and corneal elasticity, scleral stiffness, and ocular rigidity[17] (a significant risk factor for the development of AMD according to the Friedman theory[18,19]). It was proposed that the rigid and noncompliant sclera limits the filling of the vortex veins and thereby increases choroidal vascular resistance. The final result of this cascade is that there is a decompensation of the choroidal venous system at the posterior pole, the Bruch membrane, and the retinal pigment epithelium of the macular area, leading to the development of AMD.

In this study, we did not find that patients with neovascular AMD had differences in CCT measurements compared with healthy control subjects. Furthermore, in a recently published article,[20] we found no statistically significant correlation between ocular rigidity coefficient and CCT. However, as the authors state, this finding cannot be considered conclusive because the power to detect such a correlation was low (type II error = 0.64), and the measurements were made after cataract extraction (increasing the variability of the measurements caused by induced alterations in endothelial cells).

A few potential limitations are apparent in this study. The possible impact of photodynamic therapy that most of the patients with AMD had undergone and the possible existence of subclinical dry eye (patients with symptoms of dry eye were excluded) are the major limitations of this study. Furthermore, even though we could not rule out a difference as large as 11.41 μm (mean difference, 5.09 μm; 95% CI, –1.23 to 11.41), it seems that there was not any clinically meaningful difference (as has been described in the literature from several previous studies[21–24]) between the 2 studied groups.

In conclusion, despite the described limitations of the study, patients with neovascular AMD do not seem to have differences in CCT measurements compared with healthy control subjects.

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