

# Progression of Pellucid Marginal Degeneration and Higher-Order Wavefront Aberration of the Cornea

Kazutaka Kamiya\*, Yoko Hirohara<sup>†</sup>, Toshifumi Mihashi<sup>†</sup>,  
Takahiro Hiraoka<sup>‡</sup>, Yuichi Kaji<sup>‡</sup> and Tetsuro Oshika<sup>‡</sup>

\*Division of Ophthalmology, National Tokyo Hospital, Tokyo, Japan; <sup>†</sup>Technical Research Institute, Topcon Corporation, Tokyo, Japan; <sup>‡</sup>Department of Ophthalmology, Institute of Clinical Medicine, University of Tsukuba, Ibaraki, Japan

**Purpose:** To report the time course of changes in corneal wavefront aberrations in a patient with pellucid marginal degeneration.

**Case:** A 59-year-old man with pellucid marginal degeneration was followed-up annually with slit-lamp microscopy and videokeratography for 11 years. The anterior corneal height data of the videokeratography were expanded into the set of orthogonal Zernike polynomials to calculate wavefront aberrations for the central 3-mm cornea.

**Observations:** Although the patient complained of gradual deterioration of vision, there was no evident sign of disease progression on slit-lamp examination and visual acuity measurement. Color-coded maps of videokeratography showed slight deterioration over time, but no remarkable and decisive changes were seen. Coma-like aberration displayed a gradual, but apparent increase with a 1.67-fold worsening (0.473  $\mu\text{m}$  to 0.792) during the 11-year follow-up period. Spherical-like aberration remained almost stable throughout the observation period. There were no obvious changes in crystalline lens and retina.

**Conclusions:** The results suggest that increases in coma-like aberrations of the cornea reflect the subclinical progression of pellucid marginal degeneration over the years. **Jpn J Ophthalmol** 2003;47:523–525 © 2003 Japanese Ophthalmological Society

**Key Words:** Coma-like aberration, corneal topography, pellucid marginal degeneration, videokeratography, wavefront aberration.

## Introduction

Pellucid marginal degeneration is a bilateral, peripheral corneal ectatic disorder characterized by a band of thinning 1–2 mm in width, typically in the inferior cornea, extending from the 4 to 8 o'clock position. The cornea above the area of thinning is of normal thickness but protrudes, resulting in high irregular astigmatism and deterioration of vision. The corneal topography shows characteristic and typical appearances.<sup>1</sup> Although this condition may progress slowly over a period of time, there has been no longitudinal studies on the progression of pellucid marginal degeneration, especially changes

in the corneal topographic appearance. Moreover, the influence of this disorder on the optical quality of the cornea has not been addressed quantitatively. We describe a patient with pellucid marginal degeneration who has been followed up with videokeratography for 11 years. Changes in higher-order wavefront aberration of the cornea were evaluated to see its connection with the disease progression.

## Case Report

A 59-year-old man was referred to our clinic for evaluation of large irregular astigmatism that could not be corrected with spectacles. Slit-lamp examination revealed a clear band of peripheral thinning inferiorly, located 1.5-mm from the limbus, extending from the 5 to the 7 o'clock

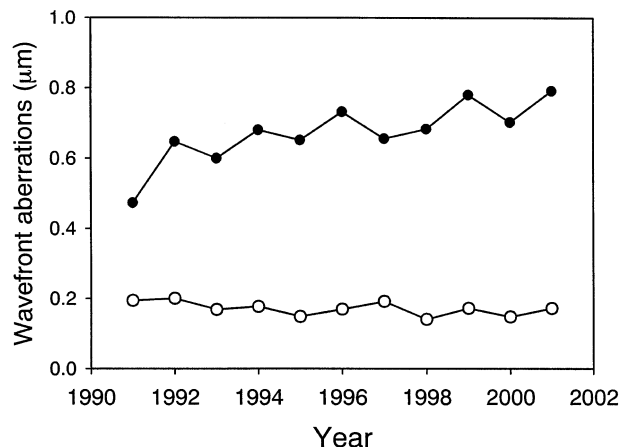
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Correspondence and reprint requests to: Tetsuro OSHIKA, MD, Department of Ophthalmology, Institute of Clinical Medicine, University of Tsukuba, 1-1-1 Tennoudai, Tsukuba, Ibaraki 305-8575, Japan

position. Anterior protrusion of the cornea was seen above the narrow band of thinning (Figure 1, left). There was no iron ring, cone, scarring, lipid deposition, or vascularization. Corneal topography obtained with computerized videokeratography (TMS-1; Computed Anatomy, New York, NY, USA) displayed marked against-the-rule astigmatism without peripheral steepening of the inferior cornea (Figure 2). The greater power was presented in a bow-tie configuration of two semi-meridians inferior and oblique to the horizontal axis. The patient's clinical pictures in both eyes were consistent with pellucid marginal degeneration. The patient was followed up annually thereafter.

During the 11-year observation period, there were no significant changes on slit-lamp examinations. Corneal topography taken every year exhibited slight deterioration in the against-the-rule bow-tie configuration, but no remarkable progression was seen (Figure 1, right). The best spectacle-corrected visual acuity remained around 20/25 to 20/30 +2.0 diopter (D) -7.0 D × 90 degrees. The patient, however, complained of mild and progressive deterioration of vision over the years. Clinically, there was no evident occurrence/progression of cataract, and the macular region of the retina remained intact on biomicroscopic examinations.

The wavefront aberrations of the central 3-mm cornea were calculated by expanding the anterior corneal height data of the videokeratography into the set of orthogonal Zernike polynomials.<sup>2,3</sup> The aberrations were calculated relative to the videokeratoscope axis, which is centered on, and normal to, the corneal vertex. The root-mean-square of third-order components of the wavefront aberration were used to represent coma-like aberration, and the root-mean-square of fourth-order components were used to

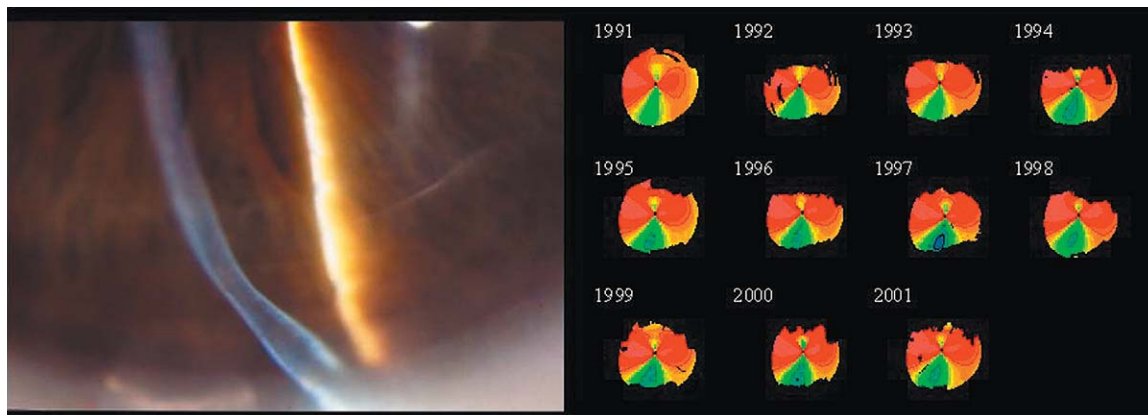


**Figure 2.** The time course of changes in coma-like and spherical-like aberrations for the central 3-mm cornea. Coma-like aberration (●) gradually increased over the years (1.67-fold increase), whereas spherical-like aberration (○) remained almost stable throughout the follow-up period.

represent spherical-like aberration. Because the videokeratography in the left eye did not have sufficient quality, only the data in the right eye were used for calculation. As shown in Figure 2, coma-like aberration gradually increased with a 1.67-fold increase (0.473 to 0.792 µm) during the 11-year follow-up period. On the other hand, spherical-like aberration remained almost stable throughout the observation period (Figure 2).

## Discussion

Applegate et al<sup>4</sup> reported that after radial keratotomy, the area under the contrast sensitivity function decreases



**Figure 1.** Left: Slit-lamp photograph of the right eye of a 59-year-old man with pellucid marginal degeneration. A clear band of peripheral thinning is seen inferiorly, located 1.5 mm from the limbus. Anterior protrusion of the cornea is present above the narrow band of thinning. Right: Corneal topographic maps (absolute scale) of the right eye with pellucid marginal degeneration. There was slight deterioration during the 11-year follow-up period, but no remarkable and decisive progression of the disease was seen.

as the wavefront variances increase. A study using aberrosopy demonstrated that low-contrast visual acuity and glare visual acuity were adversely influenced by the increases in total ocular aberrations after photorefractive keratectomy.<sup>5</sup> In our patient, despite his own complaints, there was no apparent evidence of disease progression on slit-lamp examination and visual acuity measurement. The color-coded maps of videokeratography showed slight deterioration, but no remarkable and decisive changes were seen. The augmentation of coma-like aberration was the most evident sign indicative of disease progression. It seems that gradual progression of pellucid marginal degeneration led to increases in coma-like aberration, which adversely affected the patient's daily vision. Because pellucid marginal degeneration presents in an asymmetrical fashion, it is not surprising that disease progression was reflected by the increases in coma-like aberration but not in spherical-like aberration.

It has been reported that coma-like aberrations of the cornea correlate with aging.<sup>6</sup> The yearly rate of changes in coma-like aberration, however, was reportedly rather small.<sup>6</sup> Thus, the amount of changes in coma-like aberration observed in our case, 1.67-fold increase for 11 years,

seems to exceed the range of age-related natural increases in corneal aberrations. The current findings suggest that quantitative evaluation of corneal irregular astigmatism, such as wavefront analysis of corneal aberrations, is useful in detecting and monitoring subtle progression of diseases that influence corneal contour and optical quality.

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