Fuchs’ Endothelial Dystrophy in 830-nm Spectral Domain Optical Coherence Tomography

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ABSTRACT
This article presents for the first time the potential of 830-nm spectral domain optical coherence tomography (SD-OCT) in the evaluation of Fuchs’ endothelial dystrophy. SD-OCT is an imaging technique that can be used for in vivo cross-sectional corneal visualization. The important features of SD-OCT instruments include improved sensitivity and short acquisition time, which improves the quality of the tomograms compared with conventional time domain OCT. Tomograms of the corneas of three patients in different stages of Fuchs’ endothelial dystrophy are presented. The authors conclude that 830-nm SD-OCT provides clinically valuable cross-sectional assessment of pathomorphological changes in Fuchs’ endothelial dystrophy in vivo. [Ophthalmic Surg Lasers Imaging 2008;39:S83-S85.]

INTRODUCTION
Cornea guttata corresponds to the presence of focal thickenings of Descemet’s membrane histologically named “guttae.” These are mushroom-like formations projecting into the anterior chamber. The endothelium produces excessive amounts of basement membrane material of an abnormal composition resulting in the formation of a posterior collagenous layer. The endothelial cells are thinned over the guttae and degenerated, leading to endothelial dysfunction and consequent corneal edema. At this stage, the condition is called Fuchs’ endothelial dystrophy, but some prefer to also use this term for asymptomatic corneal guttae.1,2

Specular and confocal microscopy is currently used for diagnosis and evaluation of Fuchs’ endothelial dystrophy. The recently introduced spectral domain optical coherence tomography (SD-OCT) can also be used for high-resolution corneal imaging.3,4 In this article, we present for the first time the potential of 830-nm SD-OCT in the evaluation of Fuchs’ endothelial dystrophy.

CASE REPORTS
After slit-lamp examination, SD-OCT measurements of patients’ corneas were performed with the prototype instrument constructed at the Institute of Physics, Nicolaus Copernicus University, Torun, Poland. The details of the SD-OCT instrument and its use for corneal imaging have been reported previously.5 The central wavelength of the light source is 830 nm (Δλ = 70 nm), and the axial and lateral resolutions of the instrument are 4.5 and 5 µm, respectively. The sensitivity of the prototype is 96 dB, and the scanning rate is 23 kHz per A-scan. Finally, the diagnoses of Fuchs’ endothelial dystrophy were confirmed by confocal microscopy with the use of Confoscan 4 (Nidek Technologies; Gamagori, Japan).

Case 1
A 54-year-old woman with previously diagnosed Fuchs’ endothelial dystrophy and moderate myopia in both eyes was referred to the Department of Oph-
thalmology, Collegium Medicum, Nicolaus Copernicus University, Bydgoszcz, Poland. She complained of slightly decreased visual acuity without ocular pain. On examination, her best-corrected visual acuity (BCVA) was 0.9 in the right eye and 0.8 in the left eye. Her father had Fuchs’ endothelial dystrophy. Both slit-lamp and confocal microscopy examinations confirmed the diagnosis of early Fuchs’ endothelial dystrophy. SD-OCT images of her left cornea showed highly reflective, irregular posterior surface of the cornea with formations protruding to the anterior chamber and corresponding well with morphology of the guttae (Fig. 1). Moreover, several small hyporeflective areas indicated the presence of fluid, mostly in the posterior corneal stroma. Central corneal thickness was 559 µm.

Case 2
A 79-year-old man, the father of the woman described as case 1, with Fuchs’ endothelial dystrophy in both eyes observed decreased visual acuity in the 5th decade of life. He underwent left corneal transplant surgery in 1996. His BCVA was 0.4 in the right eye and 0.8 in the left eye. The patient did not complain of current major ocular discomfort or pain. Slit-lamp and confocal microscopy examinations of the right eye showed signs of Fuchs’ endothelial dystrophy with significant corneal edema. SD-OCT images showed features similar to those in case 1, but significant thickening of Descemet’s membrane (42 µm) was also detected (Fig. 2). Numerous small hyporeflective areas are signs of fluid within corneal stroma and epithelium. Central corneal thickness was 593 µm.

Case 3
A 69-year-old woman with Fuchs’ endothelial dystrophy in both eyes complained of decreased vision in the 6th decade of life. She had had several episodes of ocular pain within the past 4 years. Her BCVA was 0.3 in the right eye and 0.5 in the left eye. Slit-lamp and confocal microscopy examinations confirmed the diagnosis of Fuchs’ endothelial dystrophy with severe corneal edema. SD-OCT cross-sectional images of the right cornea showed features similar to those described in case 2, but also had two large hyporeflective areas beneath the epithelium and increased epithelial thickness (86 µm) indicating serious edematous changes leading to early bullous keratopathy (Fig. 3). Central corneal thickness was 668 µm.

DISCUSSION
Slit-lamp biomicroscopy is a standard technique for cornea examination and it allows diagnosis of
Fuchs’ endothelial dystrophy. However, it cannot provide all of the information required for patient treatment. It is necessary to check central corneal thickness and to perform quantitative assessment of endothelial cells. For this purpose, specular microscopy, scanning slit confocal optical system, or confocal laser microscopy are currently used. These techniques provide cellular level images and can be used for en face imaging and histological investigation of the cornea, including endothelium. Corneal thickness can also be measured.

SD-OCT, also known as Fourier domain, high-speed, or three-dimensional OCT, is a new imaging technique that can be used for in vivo cross-sectional corneal visualization. The important features of SD-OCT instruments include increased sensitivity and shorter acquisition time, which improves the quality of tomograms in comparison with conventional time domain OCT. Moreover, three-dimensional and real-time imaging are possible. The advantage of the 830-nm light source, used in our prototype, is an increased axial resolution of 4 µm compared with 18 µm achieved by the commercially available Visante instrument (Carl Zeiss Meditec Inc., Dublin, CA) with a 1,310-nm light source.

The 830-µm SD-OCT facilitates precise visualization of the pathological changes within the corneas with Fuchs’ endothelial dystrophy. It can detect gutttae, thickening of Descemet’s membrane, and stromal and epithelial edema at early stages. Moreover, this technology is capable of providing accurate measurements of not only total corneal thickness but also Descemet’s membrane and epithelial thickness. Thus, SD-OCT appears to be useful for documentation and monitoring of the progression of Fuchs’ endothelial dystrophy. Unfortunately, current SD-OCT prototypes cannot be used for quantitative endothelium evaluation.

The 830-nm SD-OCT allows precise cross-sectional assessment of pathomorphological changes in Fuchs’ endothelial dystrophy in vivo. It has the potential to improve evaluation, monitoring, and treatment of this corneal disease.

**REFERENCES**