



Original research

Objective quantification of corneal haziness using anterior segment optical coherence tomography

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Abstract

Purpose: To quantify normal corneal transparency by anterior segment optical coherence tomography (AS-OCT) by measuring the average pixel intensity. To analyze the variation in the average pixel intensity in mild and severe grades of corneal opacities.

Methods: This is an observational, cross-sectional study of 38 eyes from 19 patients with mild or severe grades of corneal opacities greater than 3 mm and a normal contralateral cornea. AS-OCT was performed centered on the opacity with a 3 mm cruciate protocol. A similar image is taken of the contralateral clear cornea in the same quadrant. The average pixel intensity was calculated in a standardized manner using MATLAB software. The institutional review board approved the study (IRB Min. No: 9786).

Result: The average pixel intensity of the normal cornea was 99.6 ± 10.9 [standard deviation (SD)]. The average pixel intensity of the mild and severe corneal opacities was 115.5 ± 9.1 and 141.1 ± 10.3 , respectively. The differences were statistically significant.

Conclusions: AS-OCT images can be used to quantify corneal transparency. Average pixel intensity is a measure that varies significantly with varying corneal opacification.

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Keywords: Corneal transparency; Anterior segment optical coherence tomography; Mild and severe grades of corneal opacities; Pixel intensity

Introduction

Optical coherence tomography (OCT) is a tool which is commonly used to assess the retina and choroid. It is based on the principle of low coherence interferometry and is capable of taking high resolution, cross-sectional images of the retina. An anterior attachment to the OCT machine allows imaging of the anterior segment, and this is referred to as Anterior Segment OCT (AS-OCT).¹ The transparent corneal dome can be assessed by different imaging modalities.^{2–5} The AS-OCT

creates cross-sectional images of the cornea and anterior segment. It is a standard diagnostic modality of imaging the cornea and anterior segment.⁶ Corneal transparency can be assessed qualitatively by slit-lamp photography, and opacities can be graded into Nebula, Macula and Leucoma depending on the density of the opacity and the clarity of the iris details seen through the opacity.⁷ Opacities in the cornea have been graded by qualitative scales.⁸ The lack of quantification greatly limits the clinical ability to notice subtle changes in corneal transparency, and can induce potential errors of documentation because of inter-observer variability. In research, qualitative scales struggle with issues of standardization and the inability to apply statistics to the data collected. Corneal transparency *ex vivo* has been qualitatively assessed

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by passing a defined beam of light through the tissue and detecting how much is transmitted without absorption or scattering. The commonly used techniques to measure corneal transparency *ex vivo*, quantitatively are tungsten light-based or laser-based bench-top optical systems.

One of the early attempts to measure light scatter *in vivo* was based on the use of an optical fiber, Scheimpflug photography, video pachometry using a slit-lamp, confocal microscopy and OCT.⁹ Various techniques have been used for segmentation of three important layers of the cornea in normal eyes using AS-OCT.¹⁰

We designed an innovative method of quantifying corneal transparency. The standardized AS-OCT photographs were processed by image analysis, and the average pixel intensity was calculated. In this pilot, cross-sectional study we analyzed the distribution of average pixel intensity in clinically normal

corneas and compared the values in patients with mild and severe grades of corneal opacities.

Methods

The institutional review board approved the study (IRB Min. No: 9786). Informed consent was obtained from all participants. The study was undertaken from January 2016 to June 2016. A cross-sectional observational study design was used to acquire data. Consecutive patients over 18 years of age that presented to the outpatient clinic of the department of ophthalmology who fitted the inclusion criteria after a comprehensive eye examination were chosen. Consecutive patients that had mild or severe grades of corneal opacity of more than 3 mm in diameter with a clear contralateral cornea were recruited. The clinical grade and inclusion criteria were assessed by two independent observers

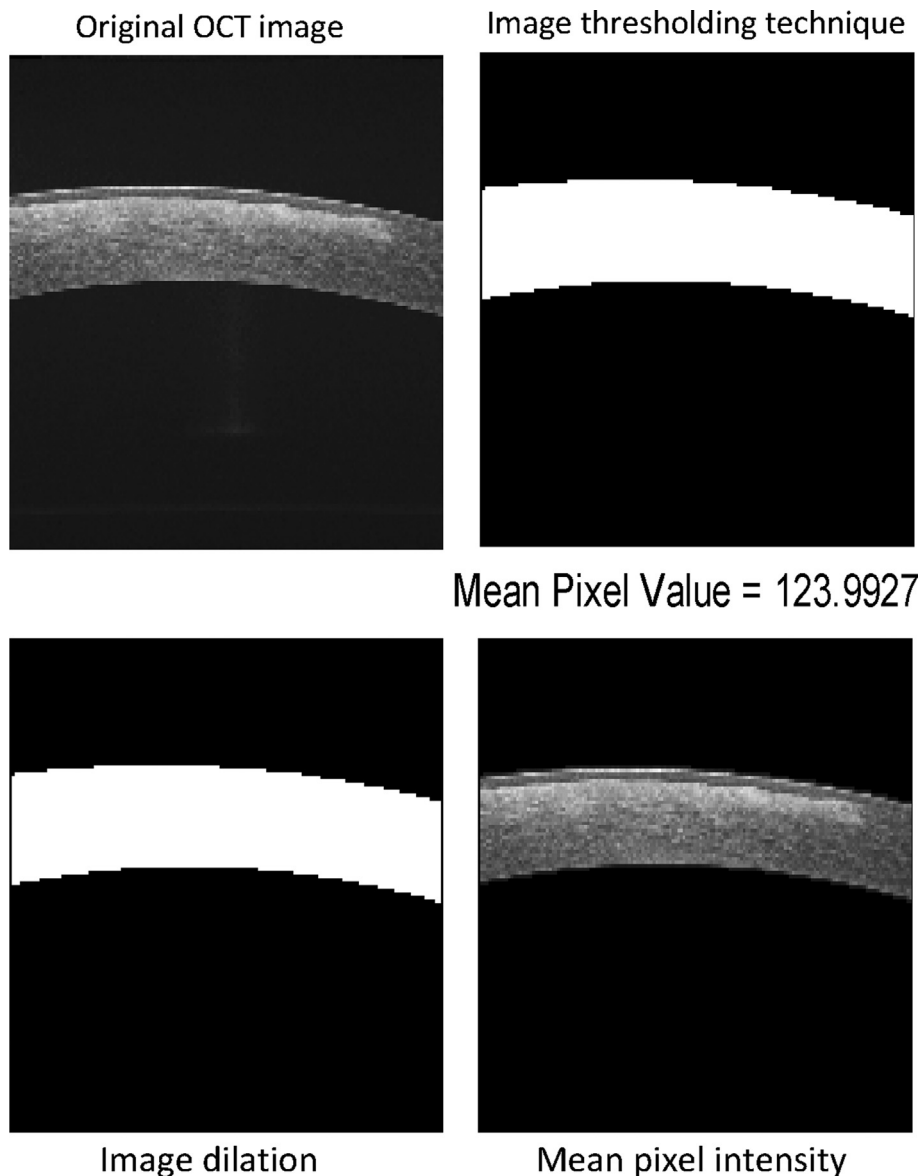


Fig. 1. Figure showing the techniques used in image analysis. OCT: Optical coherence tomography.

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