



Case Report

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Keratoconus Progression Diagnosis Evidenced by Corneal Epithelium Mapping



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Abstract

A 16-year-old man who had been presented to our practice for keratoconus displayed signs of corneal ectasia progression. These findings were supported by corneal pachymetry and keratometry measurements via Scheimpflug imaging (Oculus Ziemer II -Pentacam HR). Further examination of epithelium thickness via digital arc-scanning high-frequency ultrasound biomicroscopy revealed epithelium thickening at the pupil center, which was an indicator for the keratectasia.

Keywords: Anterior eye segment; Epithelial pachymetry; Corneal topometry; Corneal imaging; HF ultrasound biomicroscopy; Keratoconus progression

Case Report

Background

We are reporting a case of a 16y.o. (y.o.b. 1996) young gentleman that we have followed for keratoconus in our center about a year ago. His first visit occurred on February, 2011. At this time he was informed about the different options such as collagen cross-linking, INTACS, the Athens Protocol (the combination of topography-guided partial ablation PRK with CXL), and lamellar keratoplasty. Following a complete clinical investigation, recommendation was given that the OS be treated with cross-linking with simultaneous partial topography-guided excimer surface ablation (Athens Protocol) [1], which was performed in May, 2011.

The OD had reasonable good correction (BCVA 20/20) and therefore, due to his age and good corneal thickness (CCT in the vicinity of 500µm), we recommended for him to follow eight months to a year's time in order to evaluate a possible progression and the possibility of intervention. This paper is about our investigation of the OD keratoconus progression not only by optical anterior segment imaging technologies, but also by the epithelium mapping, which supported our findings relating to correlation of keratectasia and elevated corneal overall epithelium.

Methods and technologies

Anterior-segment imaging of keratometric, topometric and topographic parameters can be an important tool in the decision-

making process and prompt action. The optical instruments involved in this report were Biometry by IOL Master (Carl Zeiss Meditec Inc., USA), Anterior-Segment Optical Coherence Tomography (AS OCT) by Optovue RTVue (Optovue Inc. Fremont, CA), Placido topography and Scheimpflug topography by Wave light (Erlangen, Germany), specifically the Topolyzer and the Pentacam High Resolution (Oculus Optikgerate GmbH), a.k.a. Oculus Ziemer II, which is a Pentacam HR that has been specially configured to export topometric data to Alcon's refractive suite [2]. The ultrasound bio microscopy (UBM) instrument was the Artemis II + superior (Artemis Medical Technologies Inc. Vancouver, British Columbia, Canada) [3]. To our knowledge this is the first such documented case combining these optical modalities with epithelium mapping by HF ultrasound for keratoconus screening in the peer-reviewed literature.

Patient follow-up

The initial anterior segment parameters recorded during the first visit (late February, 2011) are summarized in (Figure 1 & Table 1). Based on these findings, astigmatism was determined -1.25 D, with the flat axis was determined at 21°. We saw the patient several months later (late January, 2012). The data (Figure 2 & Table 2), indicated keratoconic progression, despite that overall corneal thickness was found increased by an average of 13µm. For example, the difference with the Pentacam (Oculus Ziemer II) preimposed on the old and newer topometric measurement showed a change in the central steepening. For

example, sagittal curvature increased, K1 (flat axis) by +0.2 D and K2 (steep axis) by +0.8 D. Likewise, anterior surface elevation was found increased by approximately +13 μ m, also there was

change between lowest elevation to pupil center (2011, -13 \rightarrow +3 μ m, 2012 -18 \rightarrow +8 μ m). Based on these findings, astigmatism was determined -1.50 D, with the flat axis was determined at 40°.

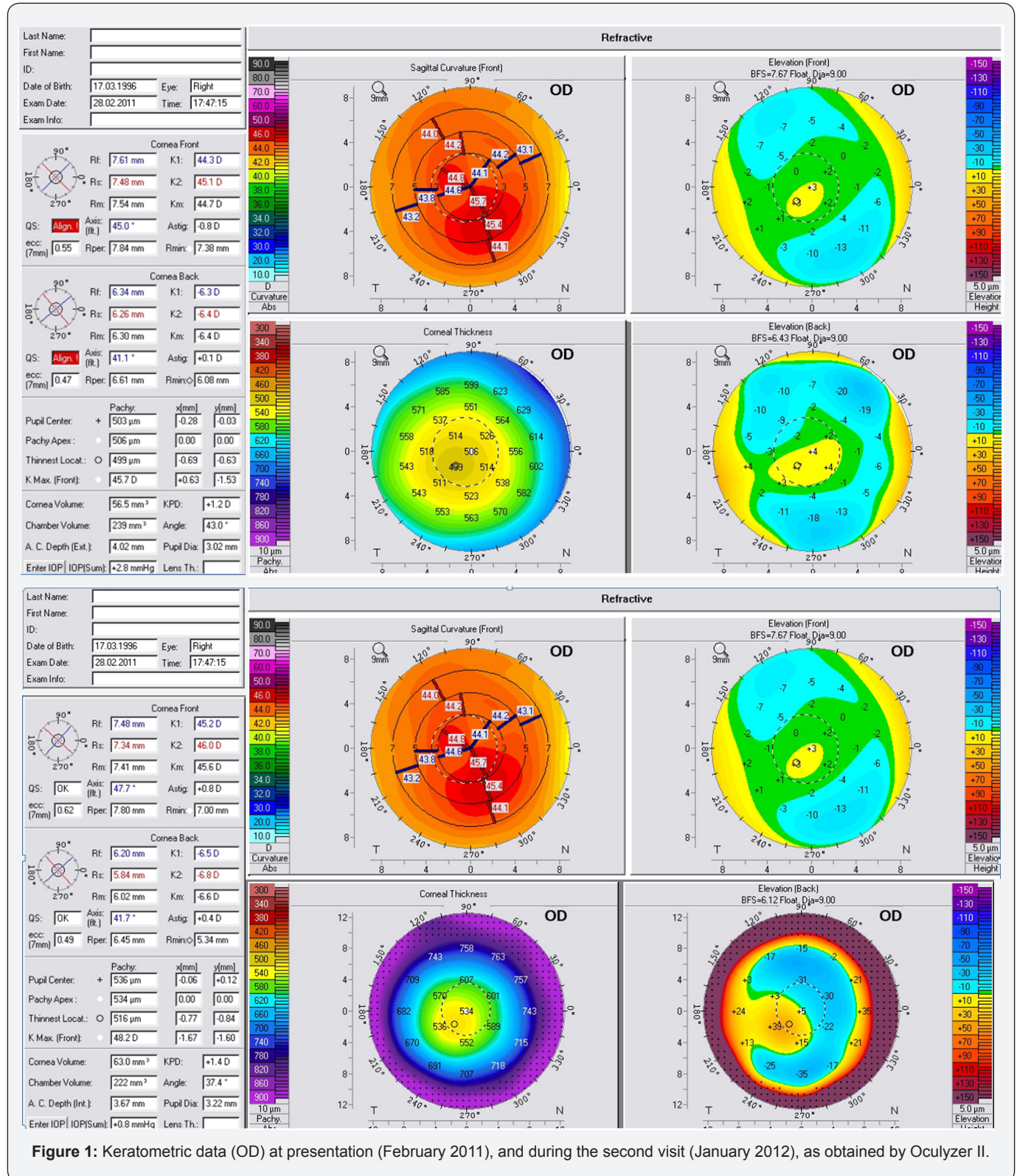


Figure 1: Keratometric data (OD) at presentation (February 2011), and during the second visit (January 2012), as obtained by Oculyzer II.

Table 1: OD corneal pachymetry and keratometric measurements during the patient's first visit.

Corneal Pachymetry				
Instrument	Oculyzer II	AS OCT		Average
CCT (μm)	499	490		494.5
Keratometry				
Instrument	Topolyzer	IOL Master	Oculyzer II	Average
Flat meridian (D)	43.9	44.88	44.3	44.36
Steep meridian (D)	45.5	46	45.1	45.53

Abbreviations: AS OCT: Anterior Segment Optical Coherence Tomography; CCT: Central Corneal Thickness; D: Diopters.

Table 2: OD corneal pachymetry and keratometric measurements during the patient's second visit.

Corneal pachymetry				
Instrument	Oculyzer II	AS OCT		Average
CCT (μm)	517	497		507
Keratometry				
Instrument	Topolyzer	IOL Master	Oculyzer II	Average
Flat meridian(D)	44.2	44.98	44.6	44.59
Steep meridian (D)	46.1	46.5	45.9	46.17

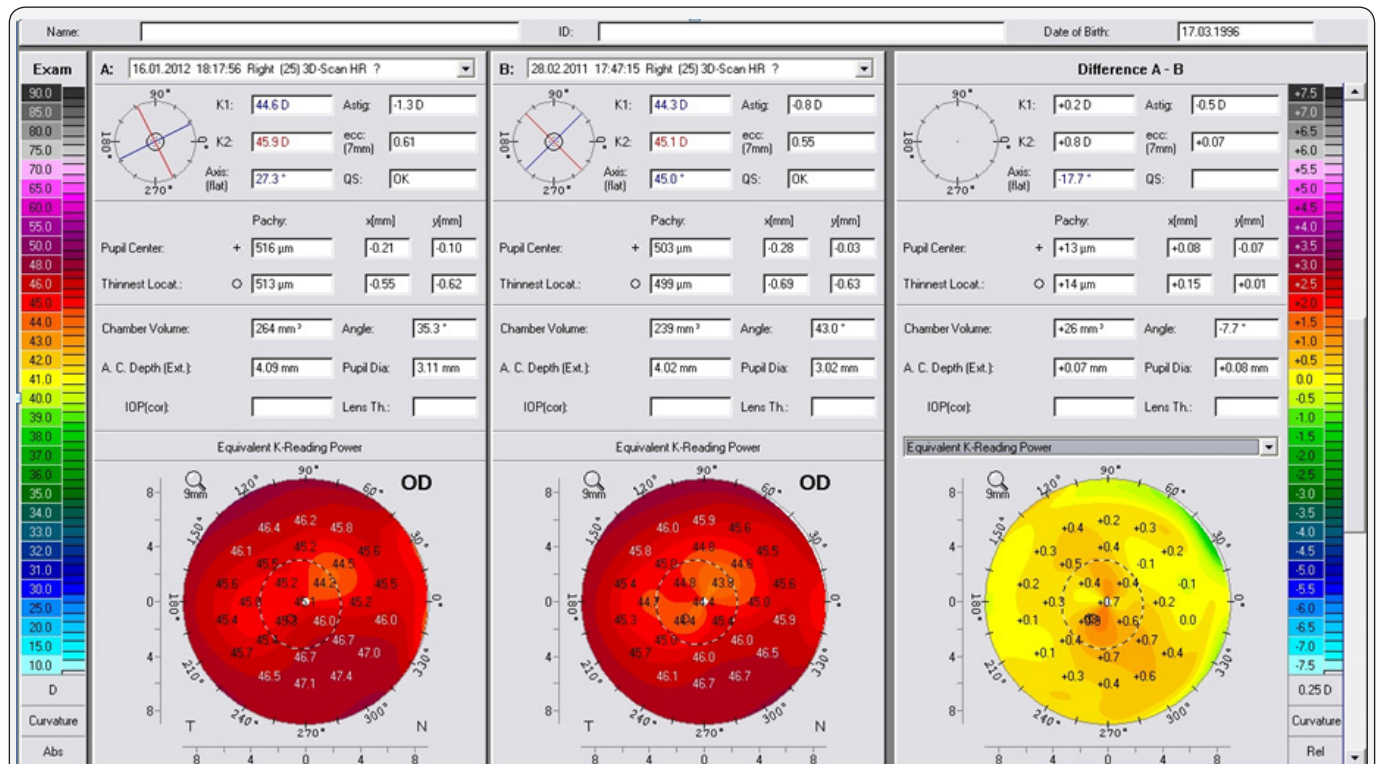


Figure 2: Comparative display of k-readings between the two visits.

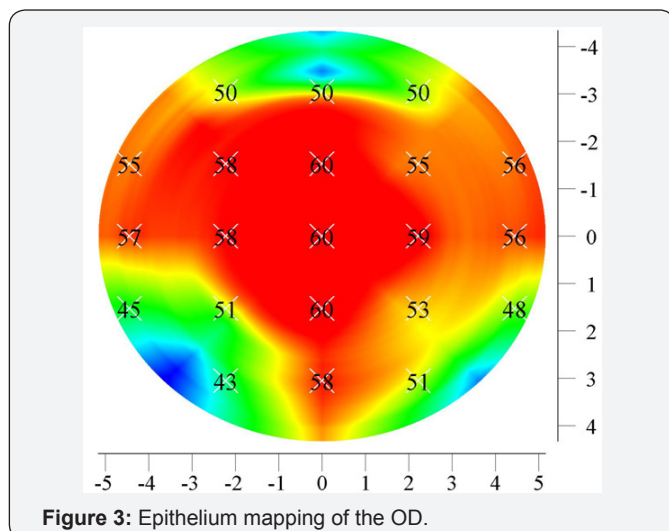


Figure 3: Epithelium mapping of the OD.

We decided to further evaluate this finding because on topometric terms this finding suggested progression of the keratoconus. We obtained Artemis II+ HF UBM corneal epithelium mapping. Careful evaluation of the UBM findings revealed that the epithelium (Figure 3) was overall thicker compared to a population of 33 patients (50 eyes) [4]. The patient's epithelium featured mean thickness 56μm (normal population 50.8μm), central thickness 60μm (normal population 52.1μm), and average peripheral thickness 50μm (normal population 49.54μm), while over the cone (located superiorly – temporal) the epithelium was thicker, at 53μm.

Discussion

We feel that this is a good example where the -at first sight-progression of keratoconus is accompanied by epithelium whose thickness is overall thicker than the control population, particularly at the pupil center by a significant amount (+8μm).

This would be impossible to establish with Scheimpflug imaging maps alone. It appears the HF Ultrasound is able, by giving the specific epithelium maps to point to that direction. Obviously, for the definite diagnosis of this theory would be re-evaluation of the cornea with Oculyzer and UBM. In case where the epithelium returned to a thinner thickness we would expect that the Pentacam maps would flatten and that would establish that there is no actual progression of the keratoconus. It is interesting to compare the posterior curvature maps of past and current and see in these maps that there is a change in posterior curvature. One has to take into account that the increase of irregularity by the epithelium thickening may be the factor that creates this bias.

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