

# How To Turn Your Aberrations From Zero to Hero: The Use of Wavefront Guided Extended Depth of Focus Scleral Lenses to Improve Quality of Life for a Presbyopic Patient with Keratoconus

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## Introduction

Scleral lenses (SLs) provide remarkable visual and quality-of-life improvements for patients with keratoconus (KCN). However, some patients are still unhappy with their vision, even with a good fitting SL. These patients often complain of ghosting and shadowing of images. Literature has reported that keratoconic eyes have more higher-order aberrations (HOAs) than normal eyes. KCN patients eventually develop presbyopia, which necessitates further correction. In the past, there was an inability from eye care practitioners (ECPs) to provide high-quality vision at all viewing distances with just SLs alone. With the advent of the OVITZ aberrometer, this gap has been bridged. SLs with HOAs and multifocal correction layered together can be provided to patients with high visual demands.

## Case History

A 57-year-old black male presents to the CL service wanting to improve his current vision. He has keratoconus, OD>OS, and had last worn rigid gas permeable (RGPs) lenses 15 years ago. He stated they were unsuccessful due to lens excessive movement. His entering acuity with current spectacles was 20/200 OD and 20/20 OS. After a thorough discussion, he was interested in trying SLs.

## CL Exam

ValleyContax's Custom Stable Elite 15.8mm lenses were trialed and ordered. The patient was told to pick up lenses when they arrived and to schedule a two-week follow-up appt.

### 1<sup>st</sup> f/u (lenses on for >4 hours):

OD: VAcc 20/40; OR plano  
Fit: 150um central clearance (CC), clears limbus 360, trace edge lift on flat meridian, deposits on the front surface, trace NaFl uptake  
OS: VAcc 20/20; OR plano  
Fit: 100um CC, clears limbus 360, good edges, more deposits on the front surface, trace NaFl uptake  
Cleaned surface with Boston Simplus; pt reports improved vision  
Plan: order new lenses with hydrapeg

### 2<sup>nd</sup> f/u (new lenses on for >4 hours):

Pt reports vision is less cloudy and more stable. However, the patient reports bothersome shadowing of letters in his right eye.  
Plan: ordered OVITZ ARES base lens with markings

### 3<sup>rd</sup> f/u (ARES base lens on for >3 hours):

OVITZ aberrometer scans done, OD only

### 4<sup>th</sup> f/u (ARES lens OD on for >4 hours):

Pt reports much less shadowing and is very happy with his vision, BCVA 20/25 OD, near acuity was 0.4/1.0M OU  
Plan: Upon further discussion with the patient, he wants to be free of reading glasses most of the time. OVITZ scans over OS reveal little to no HOAs. Planned to make wavefront-guided extended depth of focus (wgEDOF) SLs OU

### 5<sup>th</sup> f/u (wgEDOF lenses on for >4 hours):

Patient is extremely satisfied with his quality of vision at distance and near. He reports not needing reading glasses most of the time and has no issues driving at night!  
BCVA 20/30 OD, 20/20 OS, 20/20 OU @ D, 0.4/0.5 OU @ N  
OD: increased horizontal coma due to slight rotation of SLs  
Plan: fit complete, f/u 1 year or PRN

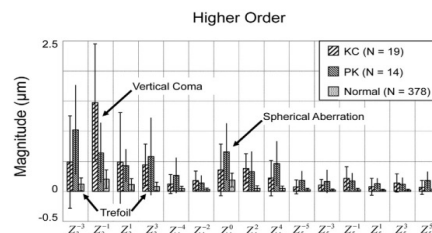


FIGURE 1: Pantanelli et al. (2009) found vertical coma (Z-1/3) to be the most prevalent aberration in patients with KCN

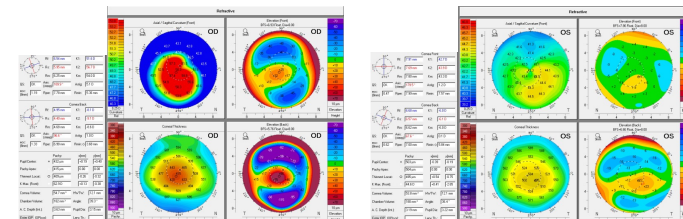


FIGURE 2: Pentacam 4 map refractive scans of the patient. OD: severe KCN, OS: mild KCN

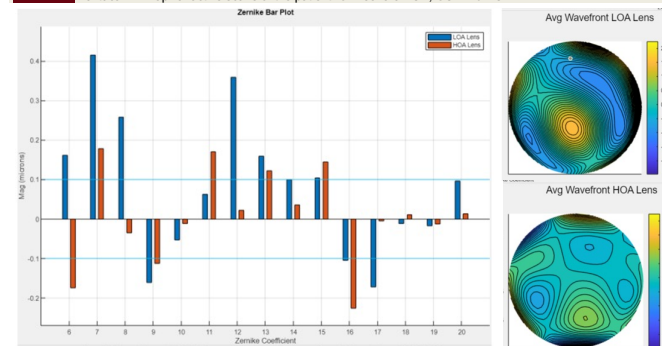


FIGURE 3: OD only, Zernike plot and wavefront map without and with wavefront correction

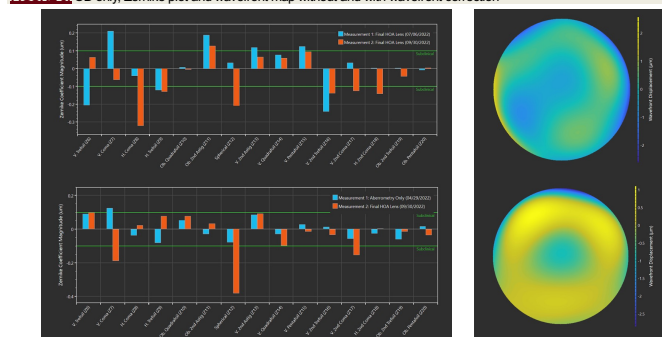


FIGURE 4: HOA+ EDOF OD, EDOF OS

## Discussion

Scleral lenses provide remarkable visual rehabilitation for patients with corneal diseases, such as KCN. However, a cohort of patients can still be unhappy about their vision even when their best visual acuity has been achieved. This subjective visual perception can be puzzling and frustrating for a practitioner. So, what is going on with KCN eyes? Pantanelli et al. characterized the HOAs in eyes with KCN using the Shack Hartmann wavefront sensor. They concluded that KCN eyes have an average root mean square (RMS) HOA of 2.24um, negative vertical coma being the most dominant HOA, and KCN eyes have 5.5 times more HOAs than normal eyes<sup>1</sup>. Although SLs can mask most HOAs, residual HOAs can arise from the posterior cornea, crystalline lens, and SL decentration. Using the OVITZ XWAVE system, the total aberrations from the SL and the whole eye are analyzed to manufacture custom wavefront-guided SLs (wfgSLs).

HOAs are detrimental to a visual system, especially in already compromised eyes. However, aberrations, specifically negative spherical aberration (-SA), can increase the depth of focus (DOF). Villegas et al. demonstrated this effect by introducing controlled amounts of -SA in patients with light-adjustable intraocular lenses (LAL). They concluded that -SA increases DOF and needs to be customized based on individual visual demands<sup>2</sup>. Like LAL, OVITZs allow for an increase or decrease of -SA, making this favorable for ECPs to provide patients with SLs that optimize vision at distance and near.

Our patient was unsatisfied with the vision in his right eye due to excessive shadowing of images. Using OVITZ, there were increased amounts of vertical/horizontal coma and SAs above the subclinical line. A WgSL corrected the significant aberrations, subsequently improving the patient's quality of vision. Further modifications to both SLs addressed the patient's inability to read. Negative SAs was introduced into his visual system, thus extending his DOF. Our patient reported minimal issues when driving at night and was free from reading glasses most of the time.

## Conclusion

HOAs can be tremendously debilitating for patients, especially those with KCN. In addition, presbyopia can further complicate an already compromised visual system. With OVITZ, lens scans were taken effortlessly and were used to create life-changing wgEDOF SLs for our patient. The patient was thrilled with the comfort and vision through his lenses. "This is truly amazing," he says.

## References

1. Pantanelli, S., MacRae, S., Jeong, T. M., & Yoon, G. (2007). Characterizing the Wave Aberration in Eyes with Keratoconus or Penetrating Keratoplasty Using a High-Dynamic Range Wavefront Sensor. *Ophthalmology*, 114(11), 2013-2021.
2. Eloy A, Villegas, Encarna Alcon, Sandra Mirabet, Inés Yago, José Maria Marin, Pablo Artal, Extended Depth of Focus With Induced Spherical Aberration in Light-Adjustable Intraocular Lenses, *American Journal of Ophthalmology*. Volume 157, Issue 1, 2014, Pages 142-149.