Role of Optic Zone Diameter on Spherical Aberrations in Orthokeratology: A Pilot Study

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Introduction

It is known that the incidence of myopia is on the rise globally. It is also known that an axial length greater than 26.0 mm increases the risk of developing devastating ocular complications.[1] While there are many interventions available for slowing axial elongation, this study focuses on orthokeratology. The purpose of this pilot study is to further explore the relationship between optic zone diameter of reverse geometry lenses and measured corneal spherical aberration induced by overnight orthokeratology.

Methods

This pilot study included three adult subjects that were fit into reverse geometry lenses for the purpose of overnight orthokeratology. Inclusion criteria consisted of subjects with refractive errors between -1.00 D and -6.00 D with less than -1.50 D of astigmatism, similar refraction errors between right and left eyes, and a lack of corneal pathology. Subjects reported for a baseline visit, a dispensing visit, one-day follow-up, and one-week follow-up. At the initial visit, baseline topography and baseline aberrometry data were collected using the Medmont Meridia and Nidek OPD-Scan III, respectively. Corneal topography was repeated at the one-day and one-week follow-up visits. Wavefront aberrometry data was repeated at the one-week follow-up visit. **Baseline corneal wavefront spherical aberration of the 4th order was compared to the one-week post-orthokeratology data collected over a 4.0 mm, 5.0 mm, and 6.0 mm pupil.**

Results

Topography:

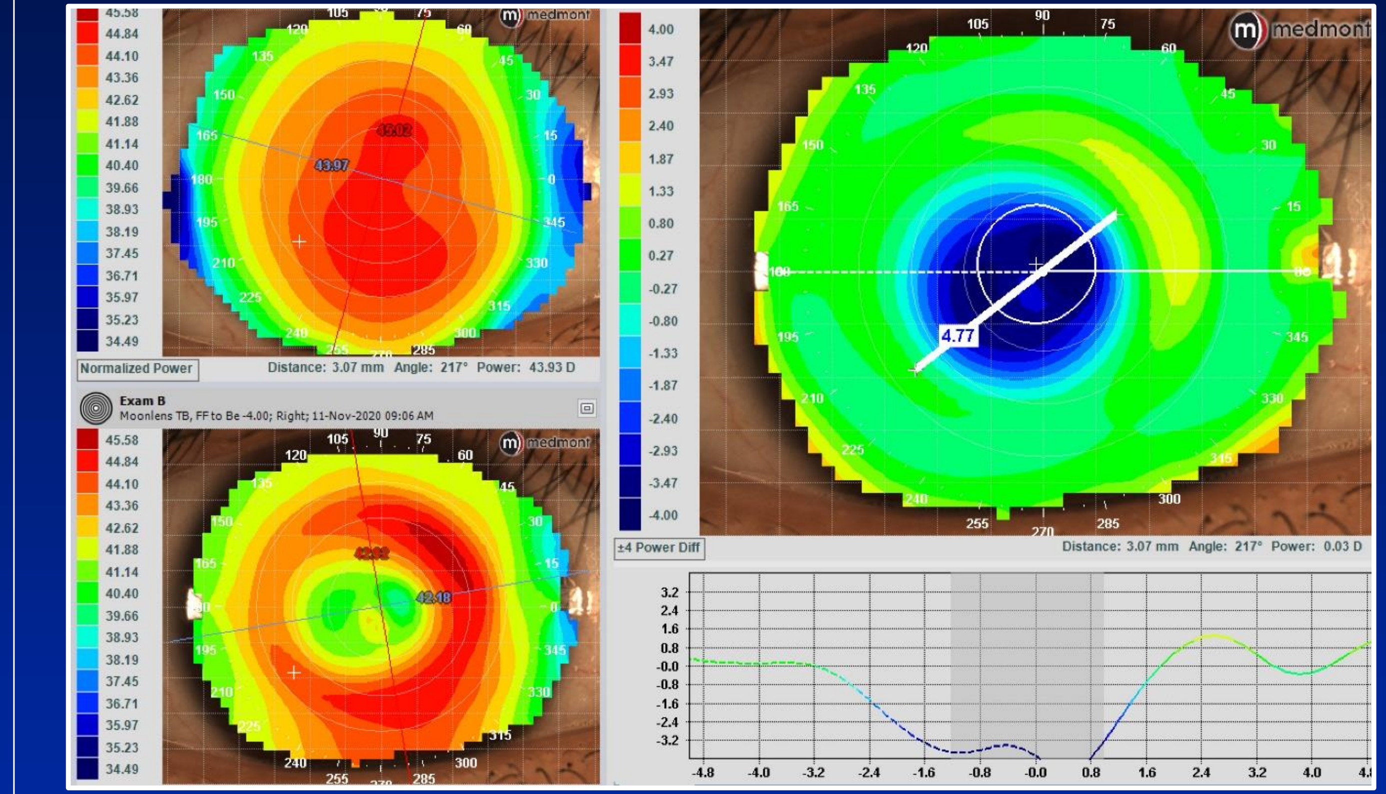

Figure 1. This figure shows the axial subtractive map for the right eye of subject A wearing the 5.0 mm OZD lens. This eye received approximately 3.77 D of flattening after one-week of overnight orthokeratology wear.

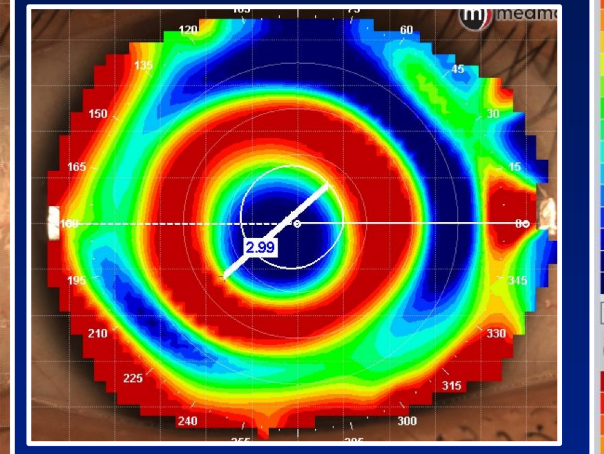

Figure 2. This figure shows the tangential subtractive map illustrating a bulls-eye pattern showing a centered treatment zone for the right eye of subject A.

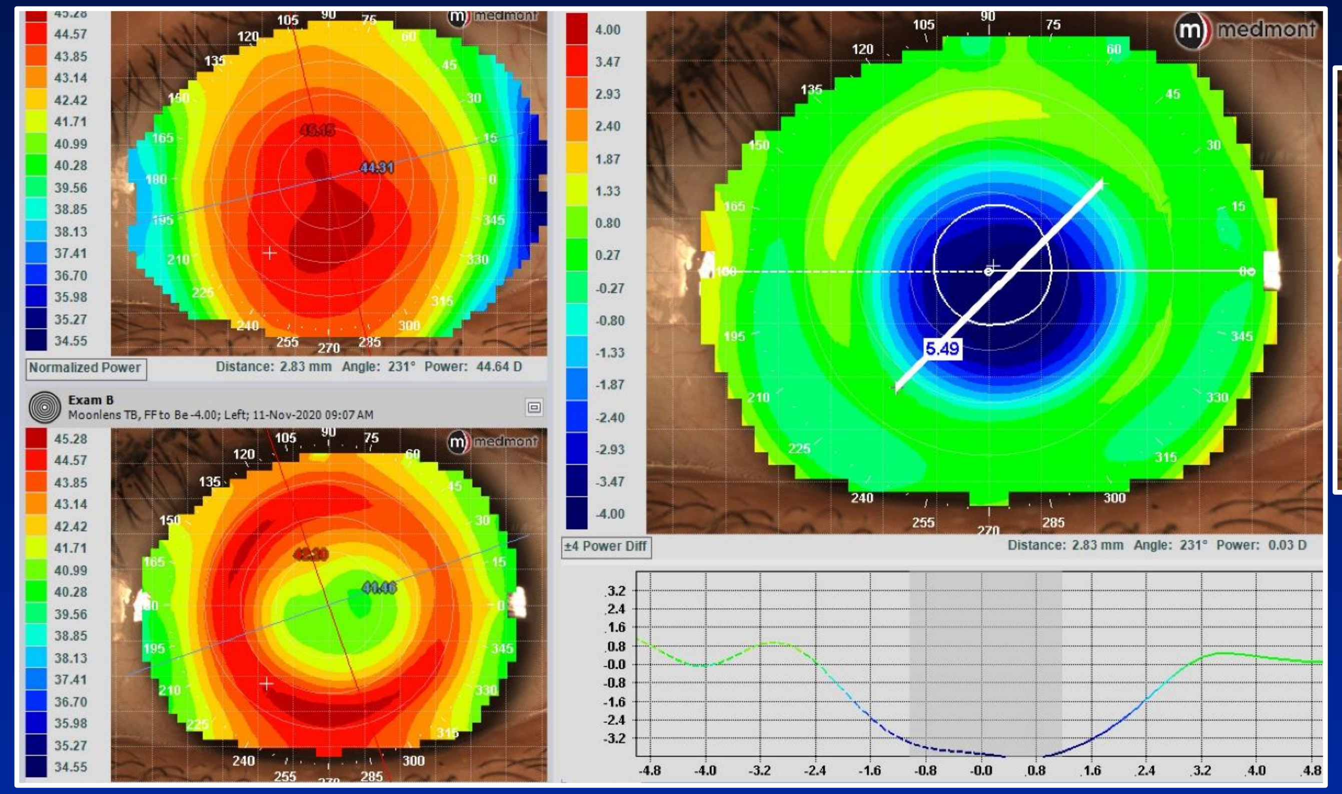

Figure 3. This figure shows the axial subtractive map for the left eye of subject A wearing the 6.0 mm OZD lens. This eye received approximately 3.75 D of flattening after one-week of overnight orthokeratology wear.

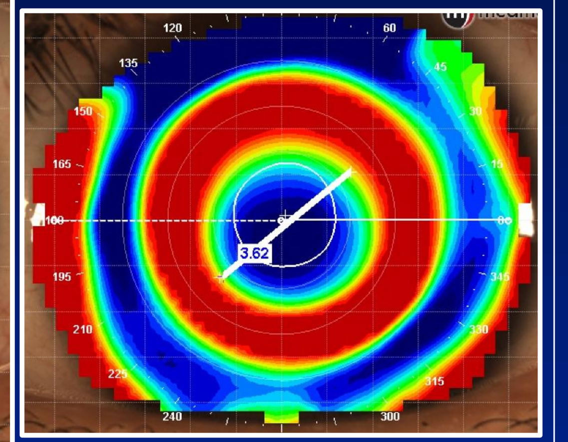

Figure 4. This figure shows the tangential subtractive map illustrating a bulls-eye pattern showing a centered treatment zone for the left eye of subject A.

Corneal Aberrometry:

SUBJECT A			
OD: 5.0mm OZD ~3.77 D treatment	4 mm Pupil	5 mm Pupil	6 mm Pupil
Baseline	0.040	0.106	0.230
1 week	0.296	0.704	1.323
Difference	**0.256**	**0.598**	**1.093**
OS: 6.0mm OZD ~3.75 D treatment	4 mm Pupil	5 mm Pupil	6 mm Pupil
Baseline	0.038	0.091	0.198
1 week	0.162	0.511	1.255
Difference	**0.124**	**0.420**	**1.057**

SUBJECT B			
OD: 6.0mm OZD ~2.30 D treatment	4 mm Pupil	5 mm Pupil	6 mm Pupil
Baseline	0.035	0.106	0.232
1 week	0.159	0.427	0.822
Difference	**0.124**	**0.321**	**0.590**
OS: 5.0mm OZD ~2.13 D treatment	4 mm Pupil	5 mm Pupil	6 mm Pupil
Baseline	0.047	0.102	0.218
1 week	0.194	0.471	0.894
Difference	**0.147**	**0.369**	**0.676**

SUBJECT C			
OD: 5.0mm OZD ~ 3.99 D treatment	4 mm Pupil	5 mm Pupil	6 mm Pupil
Baseline	0.048	0.116	0.231
1 week	0.310	0.812	1.585
Difference	**0.262**	**0.696**	**1.354**
OS: 6.0mm OZD ~3.81 D treatment	4 mm Pupil	5 mm Pupil	6 mm Pupil
Baseline	0.074	0.151	0.303
1 week	0.154	0.529	1.292
Difference	**0.080**	**0.378**	**0.989**

Table 1. This table lays out the corneal spherical aberration data collected from the NIDEK OPD Scan III. Note that for Subject B the 5.0 mm OZD is on the left eye.

At the one-week follow-up visit, all three subjects had centered treatment zones with similar amounts of flattening between their right and left eyes as measured by the corneal topography subtractive map. A general trend showed that the eye wearing the lens with a smaller optic zone diameter had induced a larger amount of corneal spherical aberrations compared to the fellow eye with the larger optic zone diameter over a 4.0 mm, 5.0 mm, and 6.0 mm pupil size. Additionally, there were no complications reported related to overnight orthokeratology lens wear.

Discussion

It appears that a higher amount of corneal spherical aberration is induced into the optical system with a smaller optic zone diameter. Other studies have suggested that increased spherical aberrations contribute to better myopic control and slowing of axial elongation.[2]

- Should we be designing all orthokeratology lenses (for myopia control) with a smaller optic zone diameter to increase the amount of corneal spherical aberration?
- Are there other lens parameters that might be modified to increase the amount of higher order aberrations thus enhancing myopia control?

Conclusion

Higher order aberrations may play an important role in myopia control and have been shown to be increased with orthokeratology.[2] Different parameters of reverse geometry lenses such as the size of the optic zone diameter can be adjusted to deliberately induce more spherical aberrations into the optical system. Additional studies need to be conducted to find out how to better control the amount of aberrations induced by reverse geometry lenses for the purposes of orthokeratology.

References

1. World Health Organization. University of New South Wales, Sydney, Australia. The High Impact of Myopia and High Myopia. Report of the Joint World Health Organization-Brien Holen Vision Institute Global Scientific Meeting on Myopia. March 2015.
2. Hughes, Rohan Pj, et al. "Higher Order Aberrations, Refractive Error Development and Myopia Control: a Review." *Clinical and Experimental Optometry*, vol. 103, no. 1, 2019, pp. 68–85.