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The role of index of refraction in the power of rigid gas permeable contact lenses

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Abstract

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The Role of Index of Refraction in the Power of Rigid Gas Permeable Contact Lenses

Justin Mans

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Pat Caroline

Thesis Title:
The Role of Index of Refraction in the Power of Rigid Gas Permeable Contact Lenses

By:
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Patrick Caroline

Student: ______________________

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Biography

Justin Mans:

I am currently a fourth year student at Pacific University College of Optometry. I received a bachelor of science from University of Oregon in general science with a minor in chemistry. Upon graduation I plan to practice at a private group practice in Florence Oregon.

Introduction:

The purpose of this study was to determine what the role of the index of refraction for different materials plays on power of an RGP contact lens. The study looked at both single vision RGP's of two different materials and also Aspheric RGP's of two different materials.

An Aspheric RGP is any design of lens in which both the distance and near powers position in front of the pupil at the same time so that each contributes to the retinal image. No or limited movement of the lens is required. The patient sees multiple images at once which are focused and out of focus (Figure 1). At a given distance, the brain selects the appropriate image to focus on. The Aspheric RGP's are fit about 3 diopters steeper than K to get vaulting at the central cornea. This induces a positive lacrimal lens behind the RGP lens which is compensated for by making the lens power more negative.

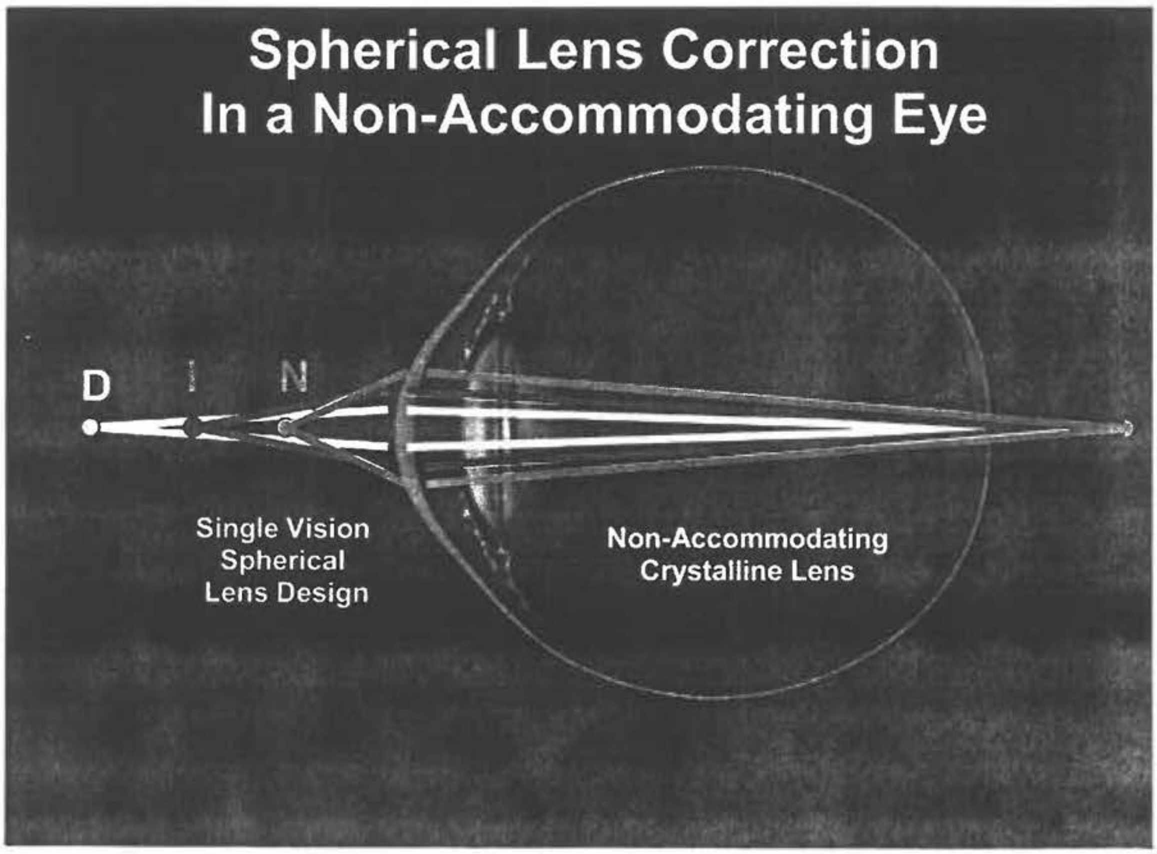


Figure 1: A spherical RGP lens

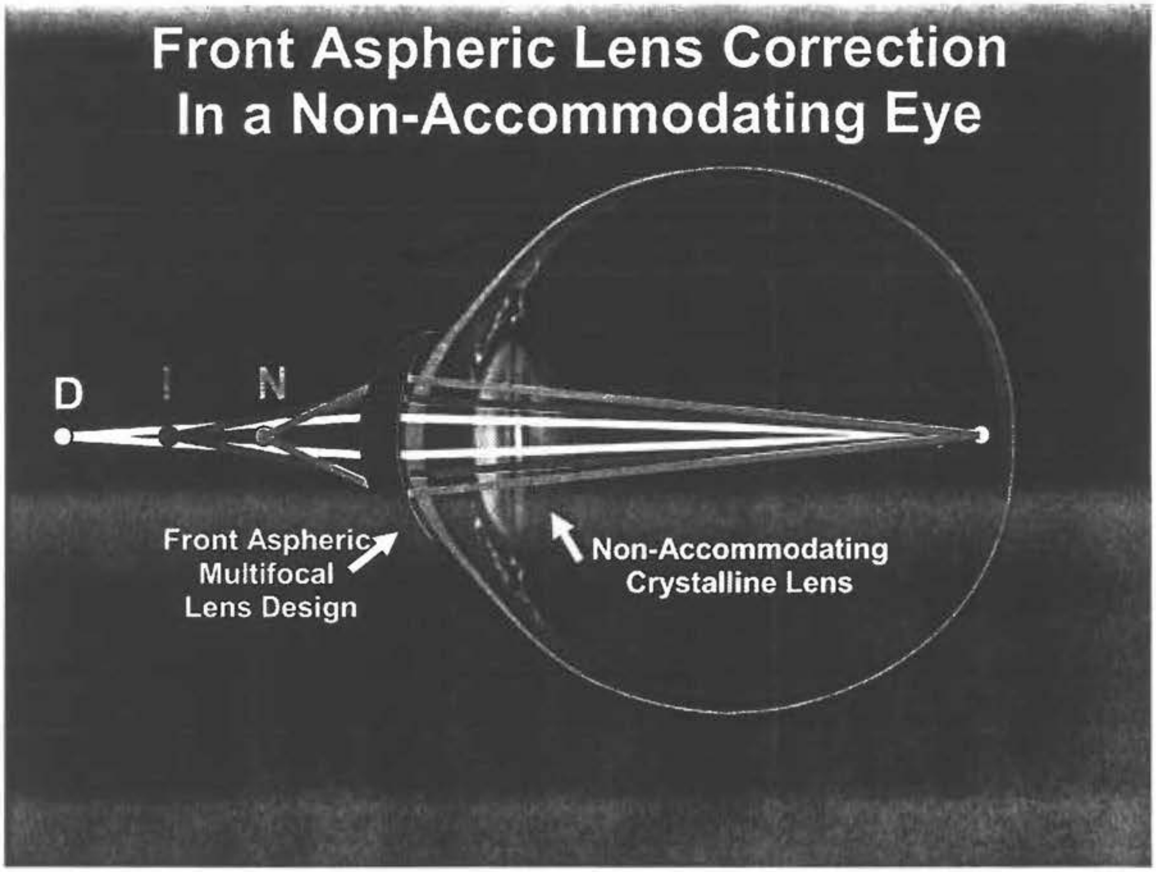


Figure 2: An Aspheric RGP lens.

Aspheric RGP's have a center for distance which is opposite of what a soft aspheric lens has (Figure 3). This is because RGP aspheric lenses move more than their soft lens counterparts and their upward translation in downgaze helps to moves their peripheral near optics into the pupillary zone. If the near zone were to be located centrally, the upward movement in downgaze would displace the near optics superiorly and bring the intermediate and distance portions of the lens into the pupillary zone, affecting near vision significantly

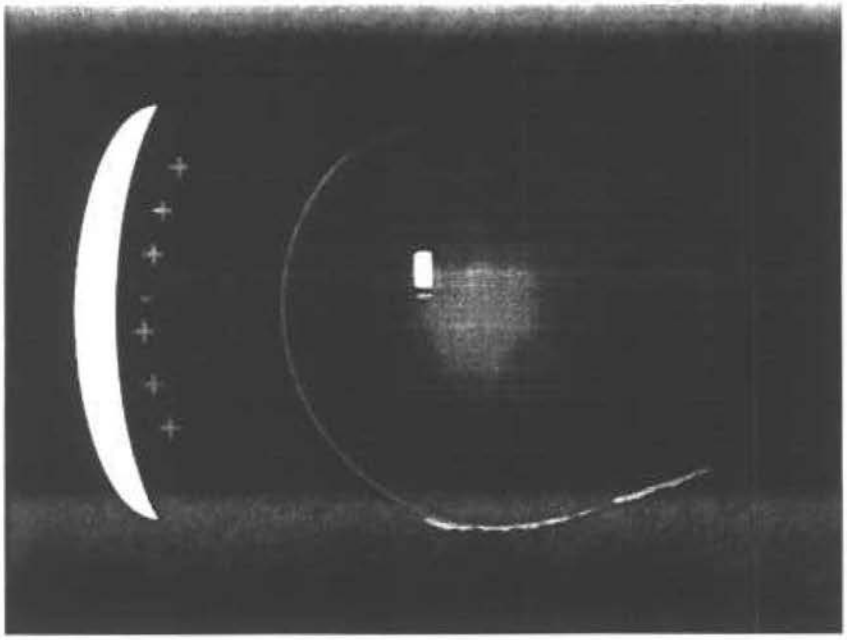


Figure 3: Design of an Aspheric RGP lens

Material and Methods:

First: IDENTICAL, **single vision lenses** with exactly the same anterior and posterior curves, in the following plastics.

- PMMA (index 1.490)
- Boston XO (index 1.415)

Both lenses would have the same posterior radius (43.00) and the exact same anterior radius. If the calculations are correct, when the resulting lenses are placed into the lensometer, the PMMA lens should read more plus power than the Boston XO.

This was also done with a **generic** posterior, aspheric multifocal design (with a posterior asphericity of 0.80) with the specification of such a design in PMMA (right lens) and Boston XO (left lens).

Material PMMA (index 1.490)

Center Thickness Power	**Anterior Curve**	**Posterior Curve**	**Expected**
0.19	7.95 mm	7.89 mm	Plano
0.15	8.321mm	7.89 mm	-3.00
0.12	8.725 mm	7.89 mm	-6.00
0.20	7.637 mm	7.89 mm	+3.00
0.28	7.348 mm	7.89 mm	+6.00

In manufacturing the (control) PMMA lenses it is imperative that the combination of the anterior and posterior radii yield the **exact,** expected powers of Plano, -3.00, -6.00, +3.00 and +6.00.

Material Boston XO (index 1.270)

Center Thickness	**Anterior Curve**	**Posterior Curve**	**Expected Power**
0.19	7.95 mm	7.89 mm	???
0.15	8.321mm	7.89 mm	???
0.12	8.725 mm	7.89 mm	???
0.20	7.637 mm	7.89 mm	???
0.28	7.348 mm	7.89 mm	???

In manufacturing the Boston XO lenses, the **posterior radius should remain constant at 7.89 mm, and the center thickness and anterior radii should be *<u>IDENTICAL</u>* to those used with the PMMA lenses.** In this way the power differences between the two materials (as measured in the lensometer) will be related to **material index only**.

Results:

The results of this study reveal two important findings, both with significant clinical implications;

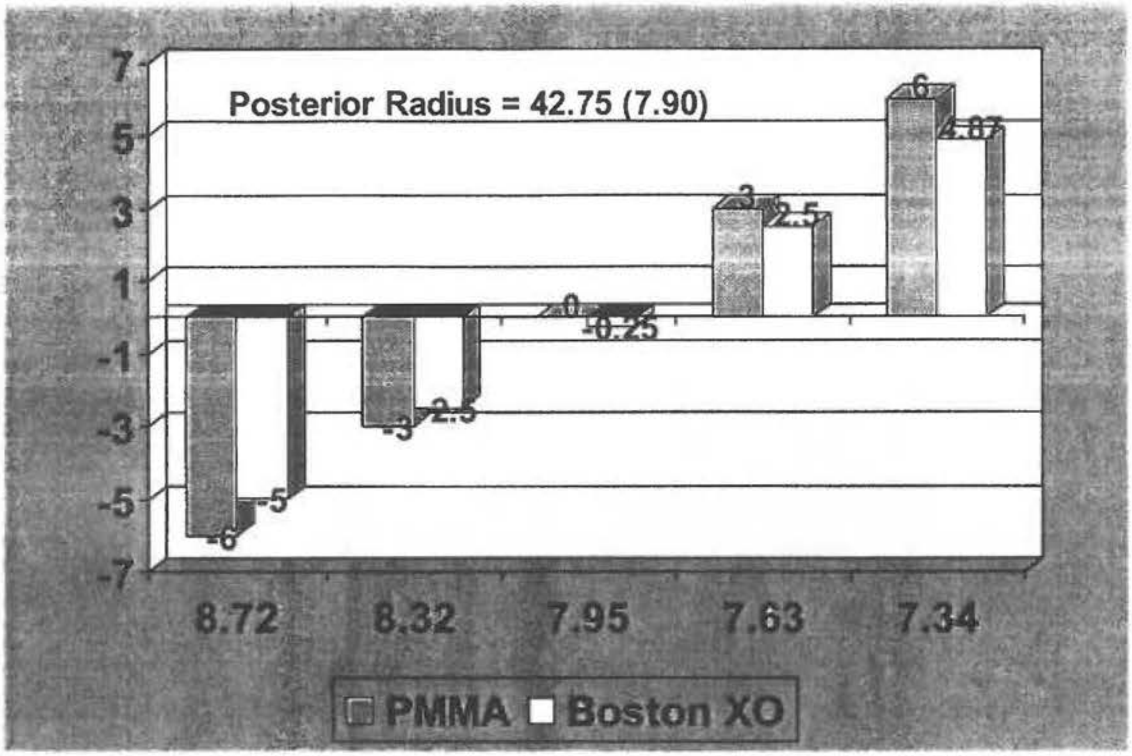
#1. the higher index material (PMMA) yielded a significantly greater overall lens power, in both myopic and hyperopic corrections.

#2. The differences in resultant lens powers appeared to change in a linier fashion with increasing myopic and hyperopic corrections.

These result validate the hypothesis that higher index RGP materials can provide additional add power in aspheric multifocal lenses.

Myopic Corections
+0.25 D. increased add.with a plano lens power
+0.50 D. increased add with a -3.00 D. lens power
+1.00 D. increased add with a -6.00 D. lens power

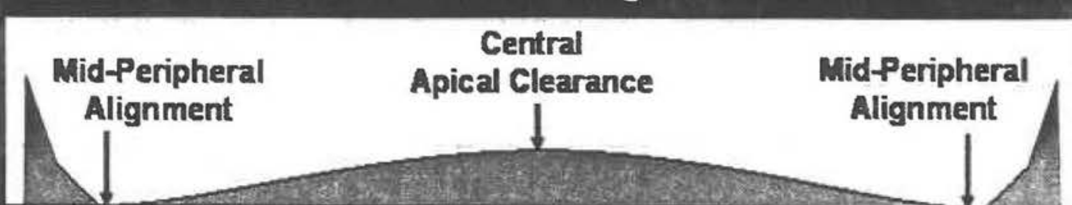
Hyperopic Corections
+0.25 D. increased add with a plano lens power
+0.50 D. increased add with a +3.00 D. lens power
+1.12 D. increased add with a +6.00 D. lens power



PMMA Boston XO

Aspheric AEL		RIGHT		LEFT		Aspheric AEL
+2.25	B	PMMA	Material / Vertex	XO	B	+1.00
Prolate	Flat	Steep		Flat	Steep	Prolate
0.80	7.35		Base Curve / Ecc	7.35		0.80
	-5.50		Power / Ecc	-5.50		
Sphere	0.13	Steeper	Center Thickness	0.13	Steeper	Sphere
Alt. PCs	10.0	Flatter	Diameter	10.0	Flatter	Alt. PCs
	8.6		Back OZ	8.6		

Tear Profile Beneath Both Right and Left Lenses



Conclusions:

The results of the experiment came out exactly as expected. The PMMA lenses which have a higher index of refraction had a higher power than the Boston XO lenses. With both lenses being exactly the same lens, just different material with a different index of refraction, this proves that the index of refraction plays a role in the power of the lens.

The same was true for the aspheric lenses. The aspheric PMMA lens which has a higher index of refraction had a higher power than the aspheric Boston XO lens. Both lenses were identical other than the material just like the spherical RGP's used in the study. The following is a list of different materials used in the production of RGP lenses and the corresponding index of refraction.

Common GP Lens Materials and Their Material Index of Refraction

Lens Material	Material Index
PMMA	1.490
SGP 2 & 3	1.480
TransAir	1.475
Paraperm 02	1.473
Boston IV	1.468
Paragon HDS 100	1.453
Contamac Classic	1.450
Paragon HDS	1.449
Boston ES	1.443
Menicon Z	1.440
Contamac Comfort	1.440
Boston RXD	1.435
Contamac Extra	1.430
Contamac Extreme	1.430
Boston EO	1.429
Boston XO	1.415

Summary:

This study was done to prove that index of refraction plays a role in the power of a lens. Although it has been known that index of refraction determines how much light is bent through a transparent medium, it has never been shown through RGP lenses. It was felt that this is an important thing to prove in a study because millions of people wear RGP lenses.

By using two lenses that were built to be exactly the same except for the material, we were able to show with a lensometer that the higher the index of refraction the more power the lens has.