

Common Misconceptions in Interpreting Corneal Topography

Cynthia Roberts, Ph.D.
Professor of Ophthalmology and Biomedical Engineering
Martha G. and Milton Staub Chair for
Research in Ophthalmology
The Ohio State University

Egyptian Ophthalmological Society

AAO Symposium

March 28, 2019

Cairo, Egypt



Biomedical Engineering



Medical Center

Disclosures

- Past Travel Funding by STAAR Surgical
- Consultant to Ziemer Ophthalmic Systems AG
- Consultant to Oculus Optikgeräte GmbH
- Advisory Board and Consultant of Optimo Medical

Biomedical
Engineering



Cynthia J. Roberts, Ph.D.

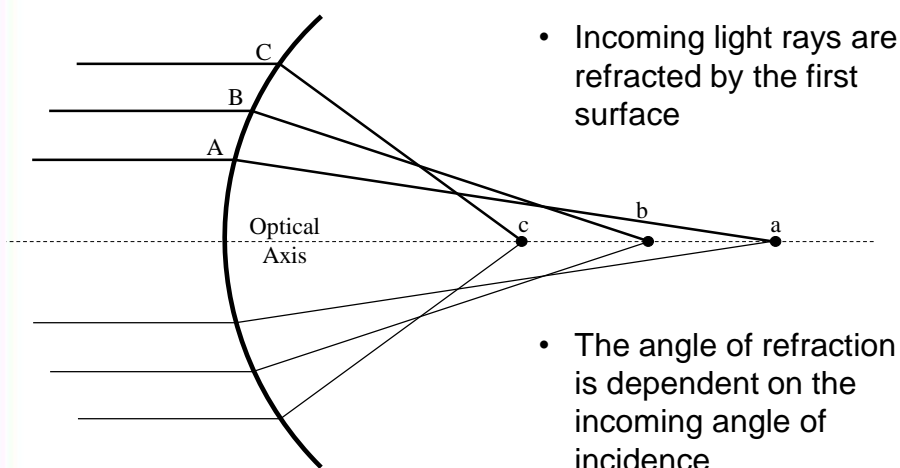
Three Top Misconceptions

- What is the Difference between Power and Curvature when both are measured in Diopters?
- How do I interpret a Pachymetry Difference Map after Refractive Surgery? Isn't the largest difference where the maximum ablation occurred?
- What is the best reference surface for elevation: best-fit-sphere or toric asphere?

Biomedical
Engineering  Medical
Center

Cynthia J. Roberts, Ph.D.

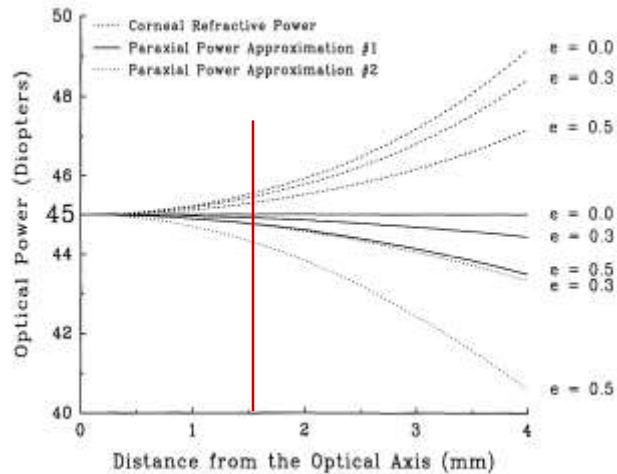
1. Refractive Power



Biomedical
Engineering  Medical
Center

Cynthia J. Roberts, Ph.D.

Power vs Curvature for a Sphere and two Ellipses



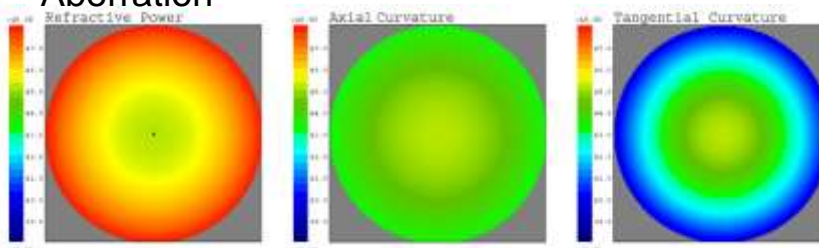
Roberts C: "The Accuracy of "Power" Maps to Display Curvature Data in Corneal Topography Systems." *Investigative Ophthalmology and Visual Science*, 1994, 35(9):3525-3532.

Medical Engineering  Medical Center

Cynthia J. Roberts, Ph.D.

Power vs Curvature

Spherical Aberration



Optical power

Axial diopters

Tangential Curvature

Power and Curvature are directly proportional

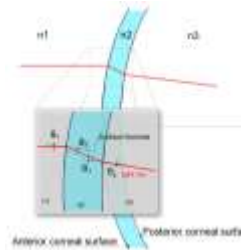
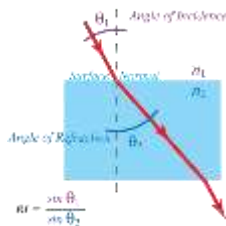
ONLY in the central paraxial region

Biomedical Engineering  Medical Center

Cynthia J. Roberts, Ph.D.

Total Corneal Power derived from anterior and posterior corneal surfaces

- Ray Tracing through BOTH surfaces
 - Snells' Law Refraction:

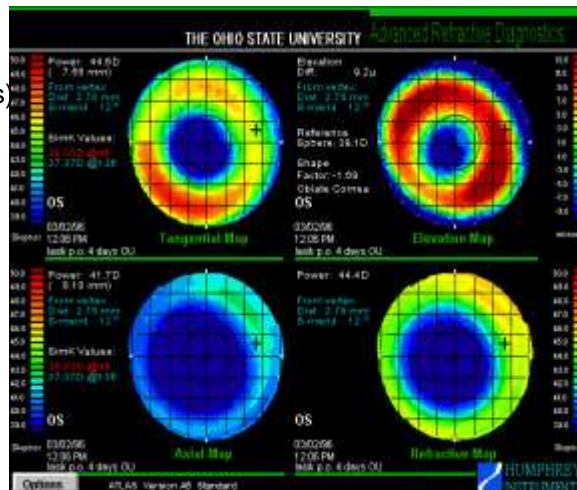


Biomedical Engineering Medical Center

Cynthia J. Roberts, Ph.D.

Post-LASIK

Tangential
(Instantaneous)



Elevation
(BFS)

Axial

Refractive
Power

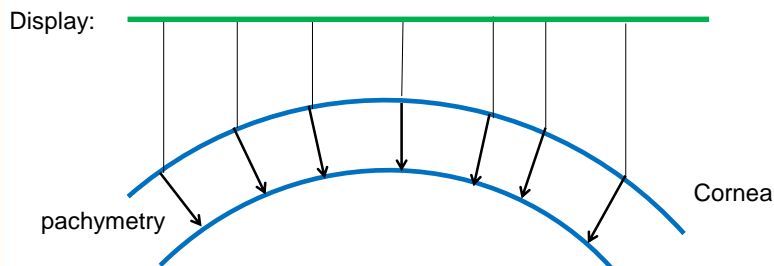
Biomedical Engineering Medical Center

Cynthia J. Roberts, Ph.D.

2. Pachymetry Map

- Measurement is normal to anterior surface (which is altered with refractive surgery)
- The normal measurement is reflected to a 2 dimensional plane for display

Reflection of Normal Measurement to 2D Map



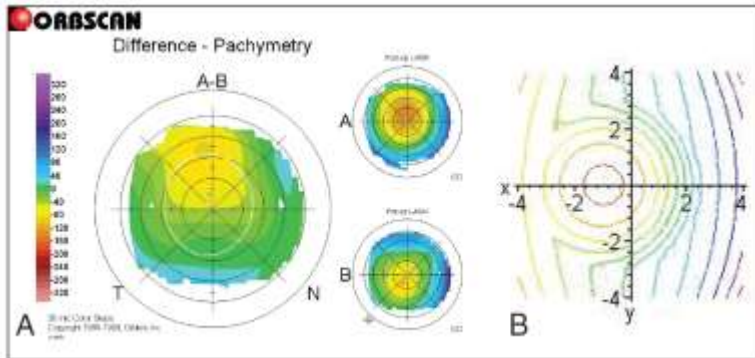
After Refractive Surgery:

1. Anterior surface is altered
2. Line of Sight may be altered


3. Pachymetry Difference Map is NOT valid

What happens with Subtraction?

- Post-op minus Pre-op Pachymetry Map
- Simulation of translation of 0.4mm and a rotation of 5°



Roberts CJ. Error in the estimation of ablation centration using pachymetric difference maps. *J Refract Surg* 2015; 31:138-139.

Biomedical Engineering 


Cynthia J. Roberts, Ph.D.

Tangential vs Pachymetry Difference Maps



- 155 eyes of 155 patients who underwent SMILE
- Vector Difference in Pre and post-op Pupillary offset significantly correlated with decentration from pachymetry maps

Chung B, Lee H, Roberts CJ, Kang DSY, Reinstein DZ, Jean SKI, Kim EK. Decentration Measurements using Tangential Curvature Topography and Scheimpflug Tomography Pachymetry Difference Maps after Small-Incision Lenticule Extraction Procedure. *JCRS*. In Press

Biomedical Engineering 

Cynthia J. Roberts, Ph.D.

What Map Should be Used?

Tangential (Instantaneous) Curvature

Measurement is along the surface


No Reference-fit like with Elevation

3. Elevation

- Anterior or Posterior Surface
- Requires a Reference
 - Relative height
 - Can be compared to a plane
 - Can be compared to a sphere
 - Can be compared to an asphere
- “Best-fit” sphere is most often chosen

Height relative to a plane reference


What conditions?

Biomedical Engineering  Medical Center

Cynthia J. Roberts, Ph.D.

Plane Reference

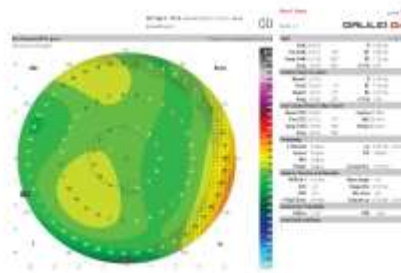
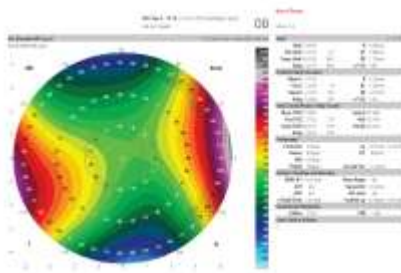
Best-Fit Sphere Reference

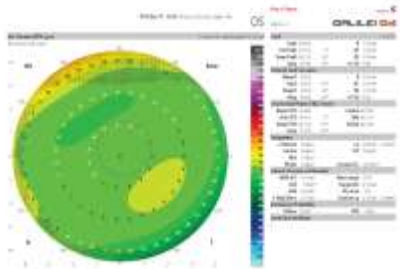
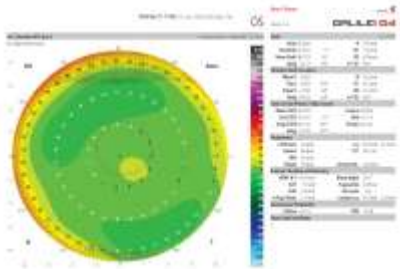
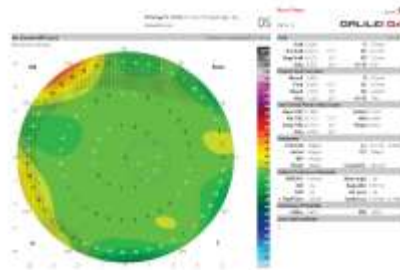
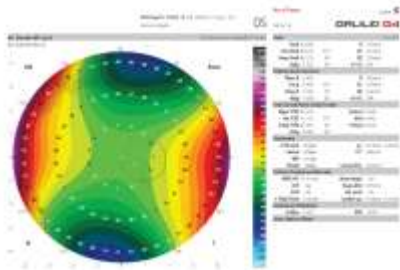
Biomedical Engineering  Medical Center

Cynthia J. Roberts, Ph.D.

What About Toric Asphere?

- Part of the shape is buried in the reference
- An astigmatic cornea will NOT appear to be asigmatic since the reference is astigmatic





Summary

- Curvature measures shape, despite diopters, and a Snell's Law refraction is required for power map.
- Pachymetry Difference Maps after Refractive Surgery are not accurate if a shift in angle kappa has occurred.
- What is the best reference surface for elevation?: Depends on Application!

Thank You!