

Times, they are a-changin'
New and Emerging Technologies in Optometry

THOMAS WONG, O.D.
MATTHEW D. BOVENZI, O.D., F.A.A.O.
(COPE Course #XXXXX-GO)

Technology in Optometry
History

A Brief History of Optometry Technology...

- × Spectacles: 1268-1289
- × Keratometer: 1851
- × Tonometer: 1865
- × Phoropter: 1921

A Brief History of Optometry Technology...

- × Direct Ophthalmoscopy: 1850's
- × Fundus Photography: 1926
- × Indirect Ophthalmoscopy: 1950's
- × ZEISS 959

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STATE UNIVERSITY OF NEW YORK
COLLEGE OF OPTOMETRY

A Quick Introduction


- **Thomas A. Wong, OD**, (SUNY Optom '89 & GU '82)
- Director of New Technologies SUNY Optometry
- Past—Chief of Adult & Pediatric Primary Care SUNY Optom
- Past— Chief of Optometry Kaiser Perm Mid-Atlantic States
- I have no consulting agreements or financial relationships with any ophthalmic companies, or any products to be discussed.



STATE UNIVERSITY OF NEW YORK
COLLEGE OF OPTOMETRY

A Quick Introduction

- **Matthew D. Boyenzi, OD, FAAO** (SUNY Optom '14 & Cornell '06)
- Assistant Chief of Primary Care (University Eye Center)
- Assistant Clinical Professor (SUNY Optometry)
- U.S. Navy Veteran; Surface Warfare Officer (2006-2010)




STATE UNIVERSITY OF NEW YORK
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The Digital Eye Care Practice of Tomorrow Presents

EYE INNOVATION HACKATHON

The Future Eye Exam

Thomas Wong, OD, FAAO
Director of New Technologies
SUNY College of Optometry

May 6, 2016
12:30-5:00 PM
SUNY Optometry

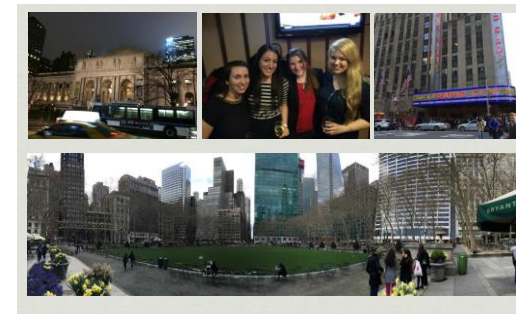


SAVE THE DATE: MAY 6, 2016 SUNY COLLEGE OF OPTOMETRY
INVITATIONS TO FOLLOW: ATTENDANCE LIMITED TO 60
Come join SUNY Optometry faculty, residents, students, researchers, practicing optometrists & ophthalmologists, and industry leaders in designing the Eye Exam of the Future.

STATE UNIVERSITY OF NEW YORK
COLLEGE OF OPTOMETRY

The Class of 2020

The World has Changed

The Future Student



—68% of today's grade school kids will end up at jobs that haven't been invented yet!!
- U.S. Department of Labor

The World is Changing

2000

- **361 million** people used the Internet (5.8% of the world's population)
- **720 million** mobile subscribers worldwide (12% of the world's population)

The World is Changing

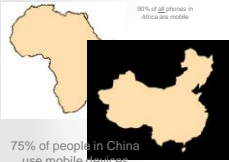
2000

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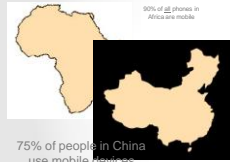
2016

- **3.4 billion** people use the Internet (46% of the world's population)
- **6 billion** mobile subscribers worldwide (87% of the world's population)

Mobile +

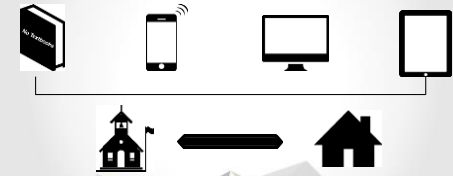


Mobile + Social



1 out of every 7 people on Earth use Facebook

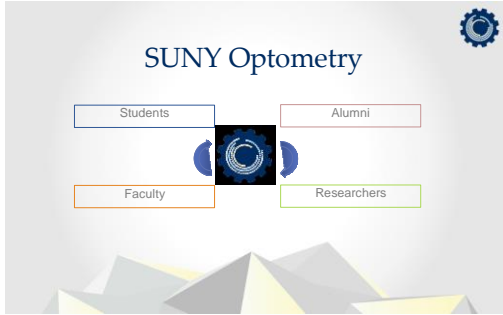
Boundary-less & Connected





Creating an Ecosystem

Innovation Through Collaboration




What is Hacking?

Taking something apart and rebuilding it to make it better, give it a new function, or just do something surprising and disruptive



What is a Hackathon?

An event where participants —hack! on a problem or focus area for an allotted period of time, with the goal of building or creating a solution (via a product, service, tool)




It's not only tech companies...



2. Identify Opportunity Areas

Understanding the user experience

IdeaScale 

An Ecosystem of Innovation


- “Split prism” cylinder axis/power refinement
 - Compare both “1” and “2” at the same time
- Compare old vs. new Rx




Ideas + Action = Hackathon 

3. Ideate Solutions 

Creativity Loves Constraint


Challenge 

Design The Future Eye Exam

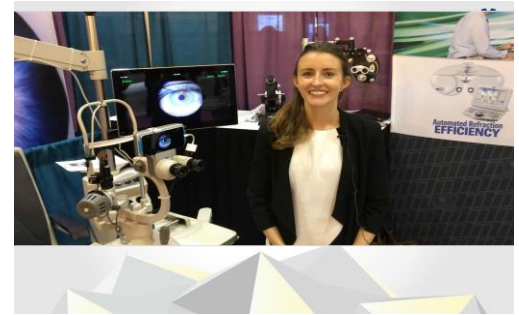
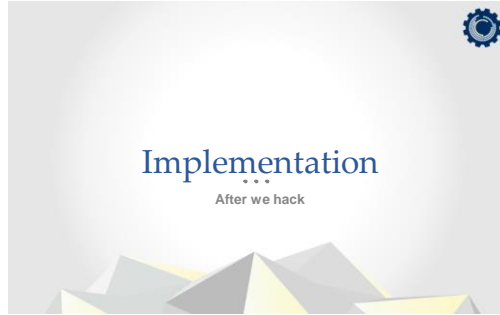
Improve Patient Outcomes

Challenge 

Optometry is a Team Sport

Goal 

Design a model eye care unit that will transform and better the SUNY Optometry student experience



New and Emerging
**Ophthalmic Lens Tech/Trends:
Blue light Blocking Lenses**

What's wrong with **BLUE**?

- ✗ Blue light is short wavelength, **HIGH ENERGY** light.

$$E = hv = \frac{hc}{\lambda}$$

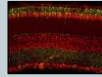
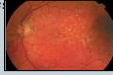
- **ENERGY is INVERSELY PROPORTIONAL to WAVELENGTH**
- Longer wavelength....lower energy
- Shorter wavelength....higher energy

What's wrong with **BLUE**?

- ✗ Blue light is short wavelength, **HIGH ENERGY** light.
- ✗ Blue and violet light have the highest energy of visible light on the electromagnetic spectrum:

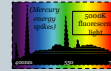
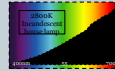
What's wrong with **BLUE**?

- ✗ High Energy light creates free radicals and oxidative stress within RPE
- ✗ Intrinsically photosensitive Retinal Ganglion Cells (ipRGC); neurotransmitter: melatonin
 - ✗ Maximally responsive to short wavelength (blue) light (inhibits melatonin release; promotes wakefulness)
 - ✗ Artificial Light At Night (LAN) proven to affect Circadian Rhythm via ipRGC pathway
 - ✗ Blue wavelengths and LAN also linked to mood and depression via ipRGC pathway



Sources of **Blue Light** Insults

- ✗ Compact Fluorescent light bulbs
 - ✗ Environmentally and economically superior to traditional incandescent lamps, but...
 - ✗ Transmit much more high-energy blue light (due to Mercury in fluorescent bulbs)
- ✗ LCD Screens (on phones, tablets, personal computers, televisions) also emit high amounts of blue light



Blue Light – Blocking Lenses/Coatings

- ✗ HOYA
 - ✗ RECHARGE Coating
 - ✗ AR coatings
 - ✗ Blue light transmittance by 10% compared to standard
 - ✗ BluTech Lenses
 - ✗ Ocular lens pigment derived from auto-oxidation of 3-hydroxykynurenic acid
 - ✗ Pigment combined with melanin and infused in optical lenses
- ✗ Essilor
 - ✗ Crizal Prevencia
- ✗ Zeiss
 - ✗ DuraVision BlueProtect

RECHARGE



Wavefront Refraction

An Integrated Measurement of the Optical Pathway with Wavefront Analysis

Poll Question

- Do you utilize wavefront aberrometry in your screening procedure?
- If yes please send the message →Wavefront to my twitter account: @tawong



Technology/Gadgets

- × 1st Tenet of the Hippocratic Oath is
- × Do what is in the best interest of
- × Your Patient!

- × –Medicine begins where the
- × Technology ends!
- × Edmund D. Pellegrino, M.D.
- × The Father of Modern Clinical Bioethics



Helmholtz Invented the Ophthalmoscope in the 1860's



Optometry's History

- Optometry has a long history of providing quality eye care
- Optometrists are eye measurers
- Technology has made a major impact on Glaucoma Tx
- Technology has made a major impact on CL care
- Technology has made a major impact on Low Vision care
- Many optometrists practice very differently than how they were taught in Optometry School
- Optometry needs to move from –Data Collection! to –Data Analysis!

The Future Eye Exam



Stanford Biomedical Informatics

Home About BMI Prospective Students Current Students Faculty Students and Alumni

Stanford Medicine School of Medicine Biomedical Informatics

Biomedical Informatics translates information into knowledge

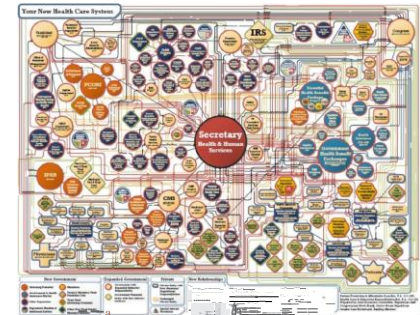
Biomedical Informatics draws data from the etiology of disease to patient drug response to bring you the medical science of tomorrow. »



IMPORTANT DATES

STANFORD BIOMEDICAL INFORMATICS

BMI NEWS



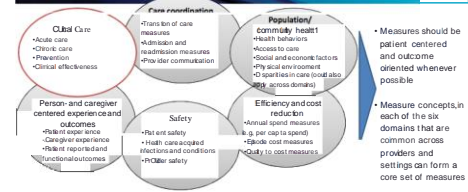


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- Outcome measure:
 - A measure that indicates the result of the performance (or non-performance) of a function(s) or process(es)
 - Outcome: Diabetic retinopathy-associated blindness
 - Intermediate Outcome: HbA1c levels

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[From presentation given by CMS Dr. Kate Goodrich]

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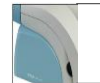


- Department of Health and Human Services (HHS) seeks to have 85% of Medicare payments tied to quality or value by 2016 and 90% by 2018
- The Merit-Based Incentive Payment System (MIPS)
 - Physician Quality Reporting System (PQRS), Value-Based Modifier (VM), and EHR Meaningful Use (EHR-MU) program payments will sunset Dec. 31, 2018, with MIPS and Alternate Payment Model (APM) incentive payments beginning Jan. 1, 2019
 - Specific emphasis on outcome measures
 - EP performance is calculated as a composite score using 4 categories: quality, resource use, clinical practice improvement activities, and meaningful use of certified EHR technology (CEHRT)

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IRAFIQU (MARCO)
 KR-1W (HOCON)
 PROFILER (ZEISS)
 R (REICHART)
 YMAK PSF REFRACTOR
 ENGINE M



54

Phoropter Advancements

- Phoropter® VRx Digital Refraction System
 - Pre-programmed tests for astigmatism, phoria, binocular balance and near vision
 - Interface with pretest equipment
 - Transfers data to EMR



Phoropter Advancements



Automated Refracting Systems

- KR-1W
 - Wavefront Aberrometer
 - Rx Reliability
 - Dry Eye Assessment
 - Early pathology determination (aberrations; trefoil, coma, peripheral aberrations)
 - Transfers to the BV-5000



PSF Technology

- Based on Point Spread function principles
- Diamond Point™ Digital cutting technology
 - 5X more precise than phoropter's 0.25D increments (0.05D steps)
- True night time subjective refraction and Rx
 - Background of PSF target is darkened to stimulate night time vision conditions

PSF Technology

- Research results
 - Statistical significance PSF Refraction preferred to Phoropter Rx
 - 900 subjects at 7 US study locations (ARVO 2012)
 - 26 KC eyes
 - ×69% achieved higher VA with PSF Refractor

PSF Refractor (cont.)

- × VMax PSF Refractor obtained equal (63%) or better (28%) VA
- × 90% of patients preferred VMax PSF Refraction to phoropter



Lai ST, Vmax Vision. A Multi-center Study Of Visual Acuity Measurements And Patient Satisfaction With A Novel Subjective Point Spread Function Refractor And Standard Manifest Refraction. Presented at: ARVO 2012; 8 May 2012. Fort Lauderdale, FL.

PSF Technology

- Short refraction time (3-5 minutes)
- PSF target easier for patients compared to Snellen chart (faster and more reliable)



Refraction: Taking a Golf Lesson



The Eye's Optical Integrity

- The Eye as an Optical Instrument
- The Eye is not a camera.
- The retinal image is not the endpoint, as with a camera.
- However, a better analysis of the optical pathway is crucial.
- It will give us better objective data for better refractions and improved patient management.
- Optical Pathway= Tear Film—Cornea—Aqueous Humor—thru Iris/Pupil—Crystalline Lens—Vitreous Humor
- Angle Kappa=Angle between pupillary and visual axis—Can often be important in strabismus patients.

Xfraction Technology

OPD Scan III

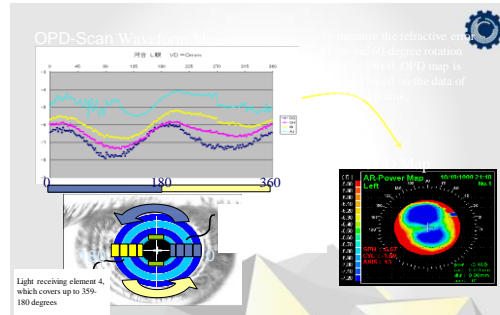
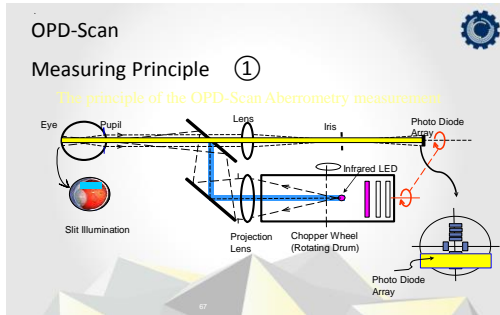


TRS 5100



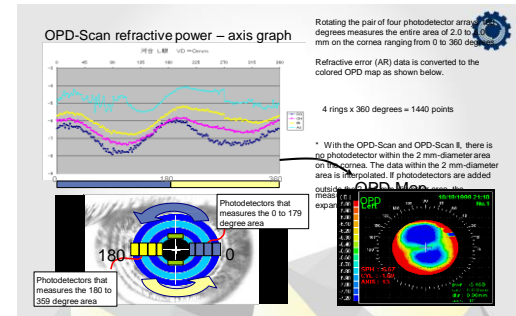
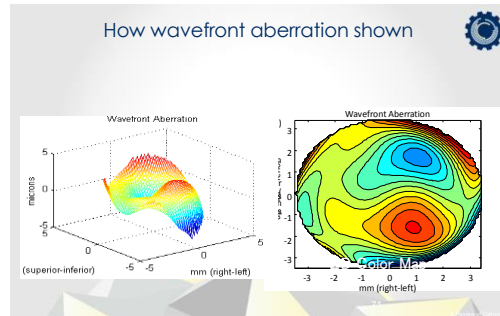
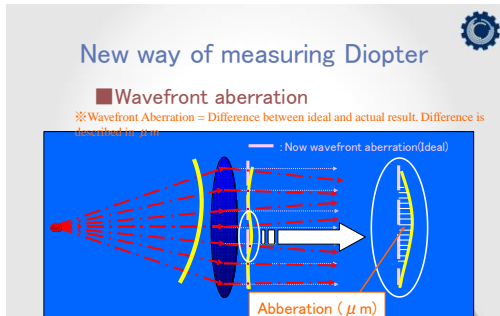
Marco Automated Refracting Lane





Wavefront Methods

Manufacturer	Principle	Wavelength	# Points	Measurement Range(D)	Zernike	Alignment†
Alcon	Hartmannschack	820nm	190 / 7mm	S -15 to +15 / C -6	8th	middle of the pupil
Bausch&Lomb	Hartmannschack	785nm	75 / 7mm	S -12 to +6 / C -6	7th	middle of the pupil
Viox	Hartmannschack	785nm	240 / 7mm	S -8 to +6 / C -5	6th	middle of the pupil
NIDEK	DynamicSkiascopy	880nm	1440 / 6mm	S -20 to +22 / C -12	8th	optical axis of the eye
Zeiss/Medtek	Hartmannschack	650nm	800 / 7mm	S -14 to +6 / C -5	10th	middle of the pupil
Schwind	Tscherning	650nm	98 / 7mm	??? / ???	6th	optical axis of the eye
WaveLight	Tscherning	650nm	98 / 7mm	197 / 197	6th	fixation beam
Topcon	Hartmannschack	840nm	125 / 7mm	S -15 to +15 / C -6	6th	middle of the pupil



Scheimpflug Principle

- Geometric rule that describes the orientation of the plane of focus of an optical system (such as a camera) when the lens plane is not parallel to the image plane. In this scenario, an oblique tangent can be drawn from the image, object and lens planes, and the point of intersection is the Scheimpflug intersection, where the image is in best focus.
- Rotating & Dual Imaging Systems available
- Examples: Pentacam, Astramax, Galilei (Placido tech also)
- Applications: Corneal Ectasia, CL Evils, Corneal Diseases
- Advantages: Irregular Corneas, Pachymetry, High Resol
- Disadv's: Corneal Power, Sensitivity to movement
- Placido based technology based on reflection principle



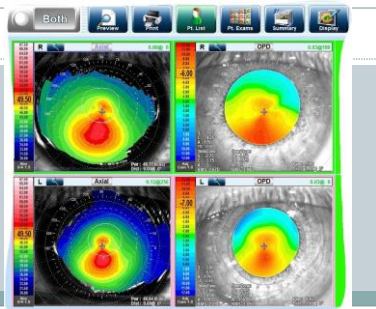
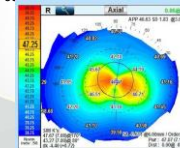
Topography & Map Displays

- Axial
- Instantaneous
- Gradient
- Refractive
- Elevation
- Eye Image
- OPD (Marco's OPD SCAN III—Optical Path Difference)
- Internal OPD



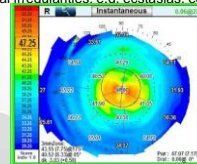
Axial Map

- The Axial Map represents the anterior corneal topography. It color codes the corneal refractive powers or curvature radiuses. The higher the refractive powers, the steeper the cornea, and the warmer the colors on the map. It measures the corneal curvature relative to the measurement axis



Instantaneous Map

- Represents the actual geometry of the cornea.
- Calculates radiuses of localized areas along the meridians.
- Also referred to as the Tangential Map.
- Shows local irregularities; e.g. ectasias, edema, scars.



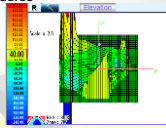
Gradient & Refractive Maps

- Gradient Map shows the amounts of variation in corneal curvature radii in the form of corneal refractive power.
- The Refractive Map demonstrates the distribution of corneal refractive power using Snell's Law. Warmer colors in the periphery of a normal cornea, and and cooler colors in the center.



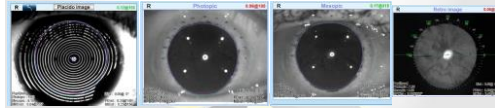
Elevation Map

- The difference in elevation between the cornea and an overlaid reference sphere (usually best fit sphere)
- 3-D Shape of the Cornea
- Useful in monitoring progression of keratoconus, S/P tissue removal, assessing post surgical visual concerns, and planning & monitoring surgical procedures



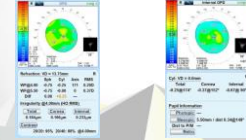
Eye Image

- To check alignment & focus of captured measurement.
- Placido Disc
- Photopic Pupil
- Mesopic Pupil
- Retro Illumination



OPD & Internal OPD Maps

- OPD Map=Refractive error at each point within a 9.5 mm diameter taking into account the cornea and all internal refractive powers.
- Internal OPD Map=The distribution of internal refractive error obtained in the OPD measurement.

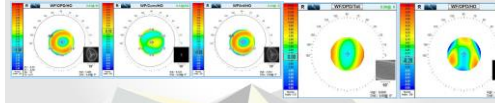


Wavefront Maps

- Wavefront Total Map
- Wavefront OPD Higher Order Map
- Zernike Graph
- Point Spread Function Map
- Corneal Images
- Retro Illumination Images

Wavefront Total & WF/OPD/HO

- Wavefront Total Map displays the difference in wavefront aberration from the wavefront of an aberration-free emmetropic eye.
- Wavefront OPD Higher Order Map displays only higher order aberrations

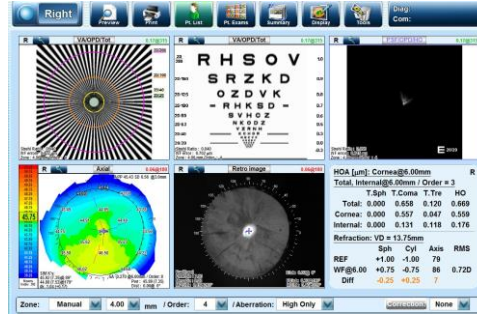
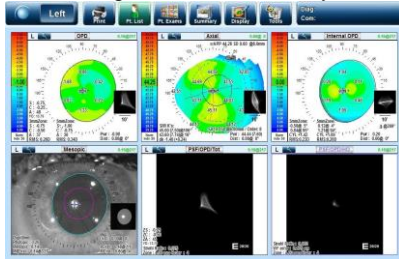


Zernike & PSF Maps

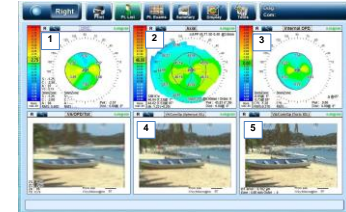
- Zernike Graph shows aberration components using the Zernike Polynomials.
- Point Spread Function Map simulates how a point source of light appears to the patient as a separate map or as a thumbnail in maps.



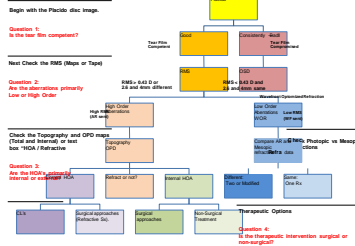
Diagnostic PSF Summary



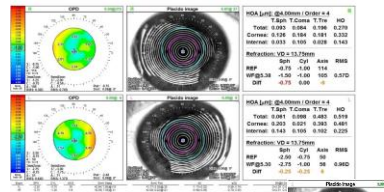
Toric Simulation



1. The QD map is the extra-visual system from the front of the cornea to the retina. This patient has 2.50 toric cylindrical correction.
2. When we design the QD into two steps (Astig and Internal QD) we actually 'undo' ~0.25D of astigmatism on the cornea.
3. The internal QD map shows 1.25D cyl. When the contact is inserted the patient will still have 1.25D of corneal astigmatism that will need to be corrected. The Astig = Internal QD + QD.
4. The color map shows how a patient will see if they are supplied a standard QD, and leave the astigmatism uncorrected. They will need to wear spectacles.
5. The Toric map shows the patient's vision with the astigmatism corrected or if they get a Toric IOL. This makes it much easier for the patient to understand that they will need correction, if the astigmatism is not addressed with the surgery.



Optical Path Diagnostics™ Diagnosis and Guiding Therapy



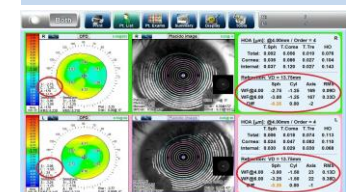
57 yo w/m. C/D increasing blur (QS-QD), variable acuity without discernable timing pattern. No pain or discomfort.

Placido image shows abnormal tear film OS > OD. This patient's dry eye therapy was started immediately rather than proceed with refraction.

Placido disc image OS shows irregular tear film, the pattern changes from measurement to measurement, but never is regular, without distortion.



Optical Path Diagnostics™ Wave Front Optimized Refraction: Day Night Summary



22 YO W/M, cis low primary glasses, using sun Rx as spare but DV blurry, NV not compromised. No other significant history.

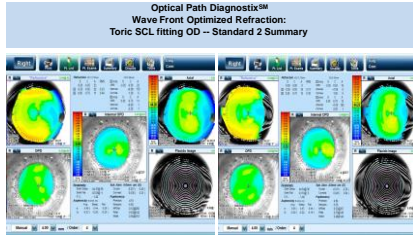
Wearing: Sun Rx: RSE; Spherical: OD: -2.25 -1.25 x 159 (20/40); OS: -2.25 -1.00 x 180 (20/40)

Day: OD: -2.25 -1.25 x 159 (20/40); OS: -2.25 -1.25 x 159 (20/40)

Night: OD: -2.25 -1.25 x 159 (20/40); OS: -2.25 -1.25 x 159 (20/40)

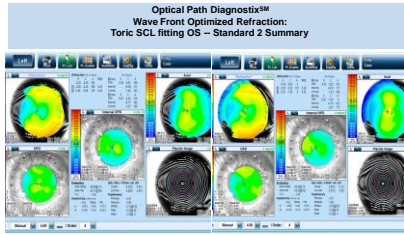
Looking at the Placido disc, tear film is normal, as in Angle Reps. The wave frontation images are clear. The 2.00mm and 4.5 mm (and 6.0 mm) pupil zone metrics are within 0.25 D of sphere and cylinder power, and the axis within 10 degrees. High order aberrations are low. Residual HO RMS, within 0.1 mm, 4 mm, 5 mm, and 6 mm pupil zones are low.

This is the patient expected to be convertible to 20/20 or better with minimal-refractive adjustments from the wavefront optimized starting point (WF) and was. The right eye required an additional -0.25 D of hyper power, and the left -0.25 D more sphere to the subjective endpoint. The patient has correction options of spherical, toric lenses, or refractive surgery. Her astigmatism was protected.



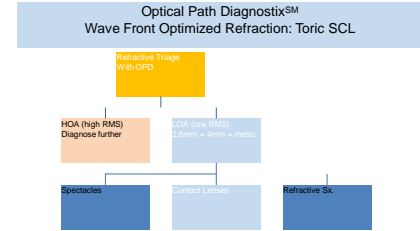
OD Initial fit of toric lens, with lens in place. 20/20. Additional -0.50 = 20/15 with -25 sphere. Dispensed this lens, FUJ 2 weeks.

OD FUJ of toric lens, with lens in place. 20/20. Additional -0.50 = 20/15. Included the additional -1.0 in trial lens, ordered the 6 month supply. Note the stability from the fit axial map showing the toric lens surface. OPD showing minimal aberrations remain. Placido shows peripheral fitting curves of lens.

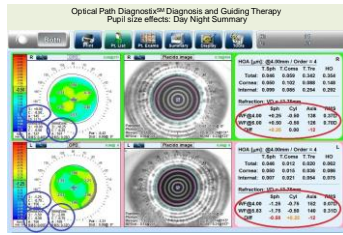


OS Initial fit of toric lens, with lens in place. 20/15.2. Dispensed this lens, FUJ 2 weeks.

OS FUJ of toric lens, with lens in place. 20/15.2. Additional -0.25 slightly better 20/15. Included the additional -.25 in trial lens, ordered a 6 month supply. Note the stability from the fit axial map showing the toric lens surface. OPD showing minimal aberrations remain. Placido shows peripheral fitting curves of lens.



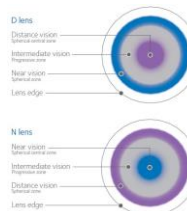
Looking at the process graphically, the OPD selected the wave front value as the refractive starting point which was verified by the subjective refraction in the TRS, and prescribed as a soft toric contact lens.



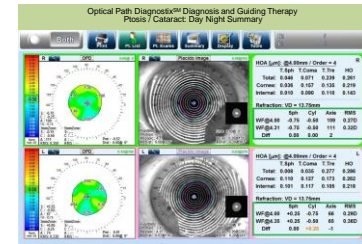
2012 exam. 58 yo WF. O.D. blur that is either occasional or intermittent, worse at night, with early (incipient) cataract OD. She works a medical technology, caring for two parents, both under Hospice care. OD: Phos. Balance (20/20) OS: -2.00 -1.00 x 110 (20/20)

OD and OS RMS indicates coma in the center. OS shows significant coma shift from 2.6 zones to 5 mm zone, and increasing + P.L.S. Ro. RMS worse at 3 mm than 5 mm and (red) based inherent RMS indicates coma in the center. OS shows significant coma shift from 2.6 zones to 5 mm zone and increasing -MUSE Ro. The cylinder power is low, not clinically significant, but the shift explains her night and variable blurring. Her work as a medical technologist has her working in variable lighting, and driving to work in photopic, near to mesopic conditions. Explained the situation, and sent FUJ 6 months based on the cataract OD.

Optical Path DiagnostixSM Diagnosis and Guiding Therapy Pupil size effects: Day Night Summary Cooper Biofinity MF

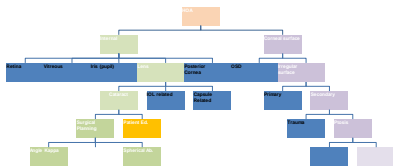


Progressive MF in two designs. D lens minus center increasing plus periphery. N lens plus center becomes more minus in the periphery. Anything familiar about that? If fit her with the low add version of the Biofinity MF which is fit utilizing an approach called -*reverse centrad* where the dominant eye gets a -D lens with the most minus power (least plus) in the center, and increasing plus as you traverse the lens from the center to the edge, the non dominant eye gets the -N lens. She has been fit with the lenses at -75 sphere low add -D lens OD 20/20 (in both rooms) and -1.25 low add N lens OS 20/20 (also in both rooms. At fu she was no longer plagued by the fluctuations, and is still 20/20.



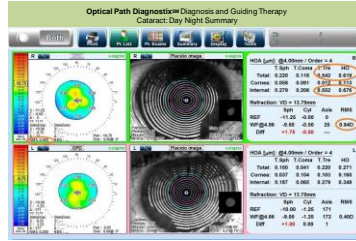
Under the influence of the Phenylophrine, the second OPD results were much more reliable, and in fact resulted in a Wavefront Optimized Refraction.

Optical Path DiagnostixSM: Diagnosis and Guiding Therapy Ptois / Cataract



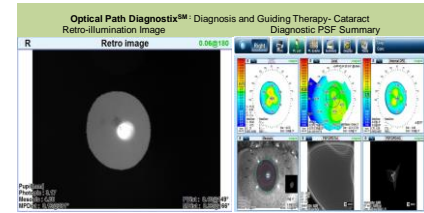
Graphically the left eye followed the light green path: HOA > Internal > Lens > Cataract > Sx Planning (Angle Kappa / Astigmatism / Spherical Aberration).

The right eye's diagnostic path is represented in the light purple path: HOA > Corneal surface > Irregular surface > Secondary > Ptois > Surgery.



59 yo w/ successful SCL MF wear x 10 years. OD increasing blur (OD/OD), MF not working as well.

The top view of the patient displays the OD and OS (diagnostic) maps. The right eye 2000 RMS value at 0.05 D indicates she would be unable to achieve 20/20 further surgery, while the left eye has an RMS of 20.0, and would be expected to be comfortable in 20/20 or better. The OPD map was the main refractive to the RMS (0.05) and working well for the patient based on the left eye results. However, the OD map indicates corneal and corneometric aberrations in the eye. The right eye's pattern is more defined as that of a cataract. The HOA table confirms that the major high order aberration responsible for the high RMS value is coma, and is present behind the corneal surface. Clinically, the correction cannot be done by normal optical means. Instead, removal of the cataract is in contact cases.



Viewing the retro images confirms the presence of a central cataract as the reason for the acuity limiting high order aberrations.

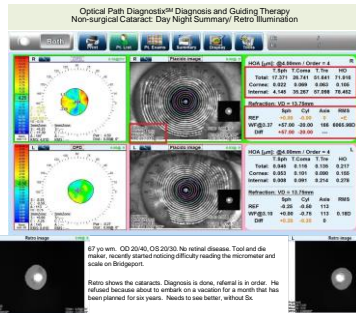
The comparison of the total OPD, Internal OPD and Axial maps show where the problem is, and why she can't be corrected with contacts or spectacles.

The associated PSF maps show her the optical effects of uncorrectable distortion, and cataract surgery is scheduled: OD first, then OS one week later.

Optical Path DiagnostixSM: Diagnosis and Guiding Therapy Ptois / Cataract

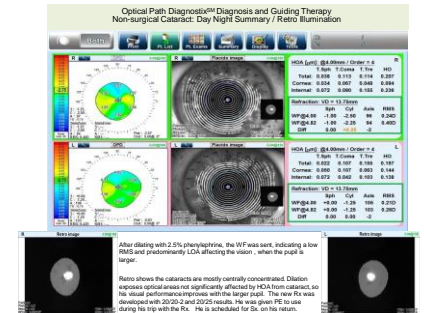


- Again, looking at the process graphically, the OPD selected the Auto-refractor value as the refractive starting point (HOA arm of the decision tree), and the OPD maps provided the diagnostic pathway to discover the cause of the high order aberrations limiting her acuity.
- The PSF maps helped the patient understand her condition and accept the prescribed treatment modality. Angle Maps, corneal spherical aberration, and the corneal cylinder values directed the selection of the specific IOL for each eye.

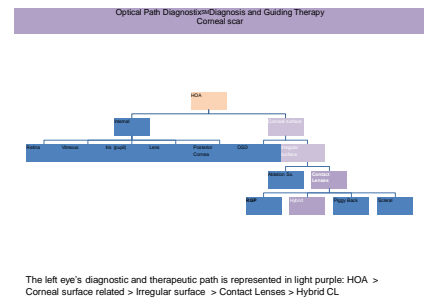
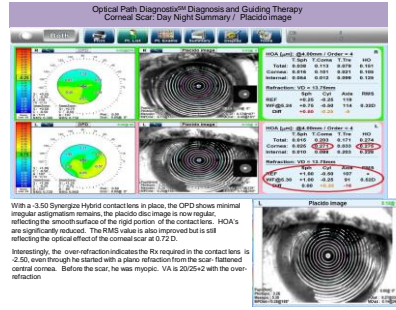
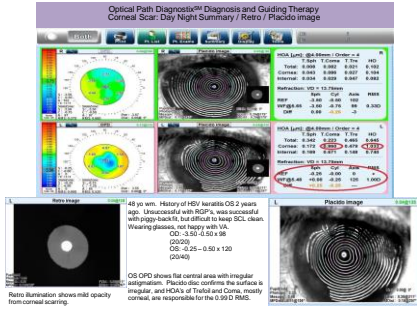


67 yo w/ OD 20/40, OS 20/30. No retinal disease. Tool and the maker, recently started noticing difficulty reading the microcurrent and scale on Bridgport.

Retro shows the cataracts. Diagnosis is done, referral is in order. He refused because about to embark on a vacation for a month that has been planned for six years. Needs to see better, without SX.

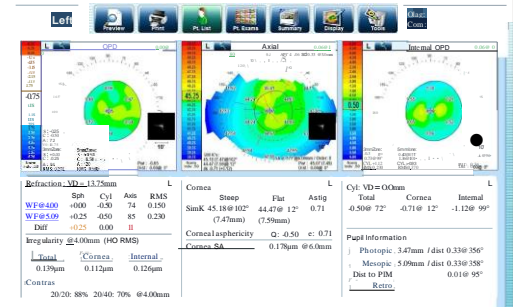
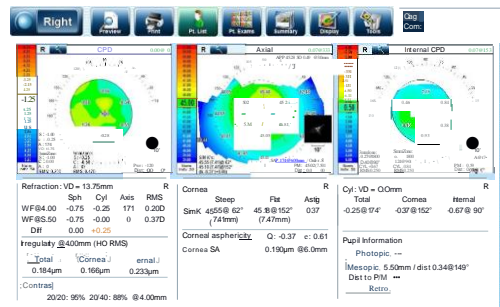


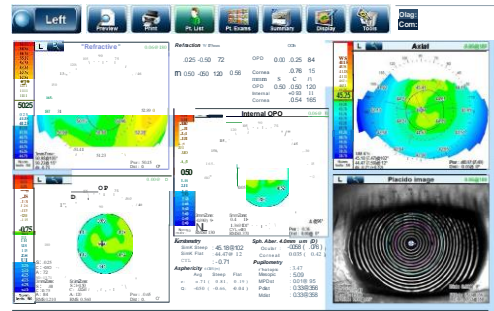
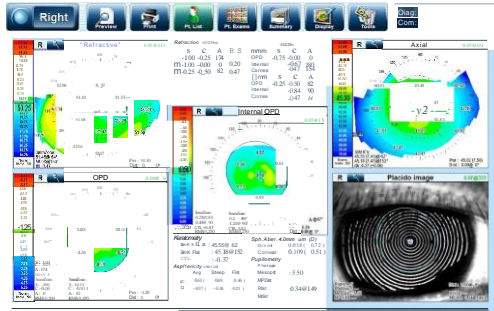
After starting with 2.5% phenylephrine, the WF was sent, indicating a low RMS and predominantly LCA affecting the vision, when the pupil is larger. Retro shows the cataracts are mostly optically compensated. Clinician exposes optical areas not significantly affected by HOA from cataract, so the visual performance improves with the larger pupil. The new Rx was developed with 20/20-2 and 20/25 results. He was given PE to use during his trip with the Rx. He is scheduled for SX on his return.



Patient A

- 53 yr old Asian Male
- Former glasses and contact lens wearer
- Wears no correction currently except for very small print
- Uncorrected Distance VA OD 20/20+; OS 20/15



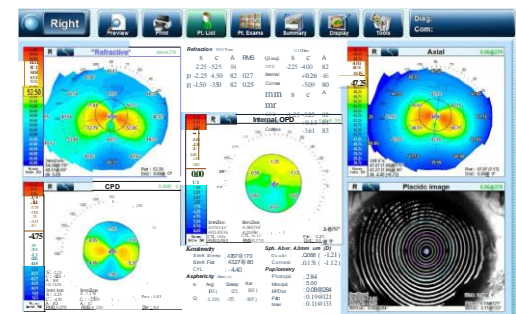
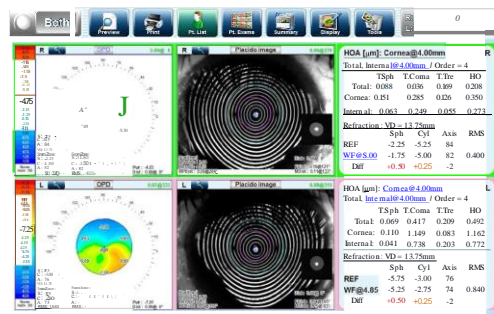


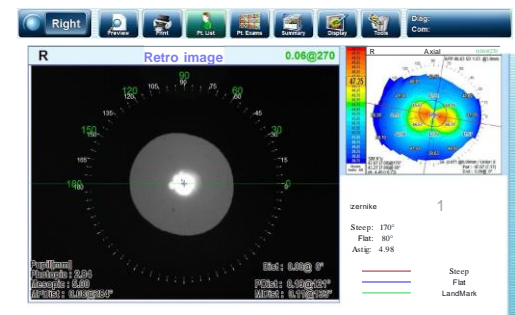
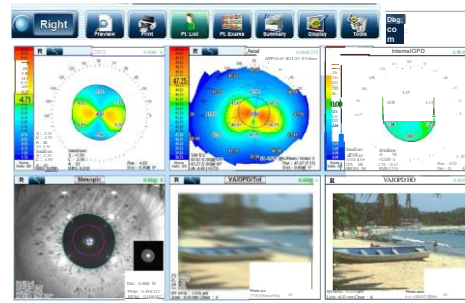
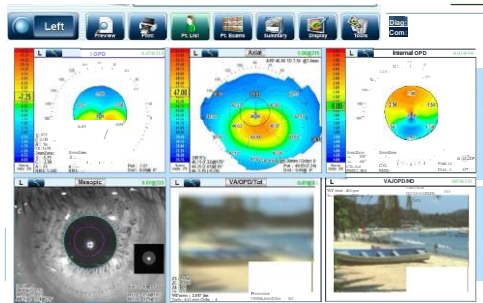
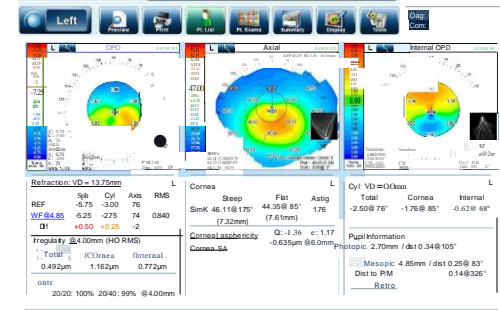
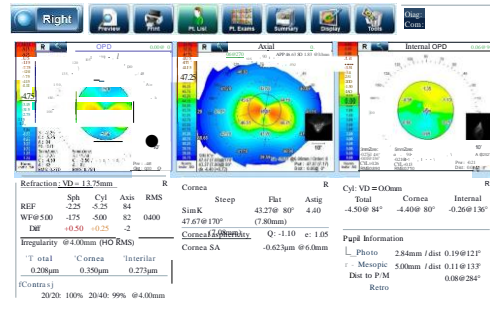
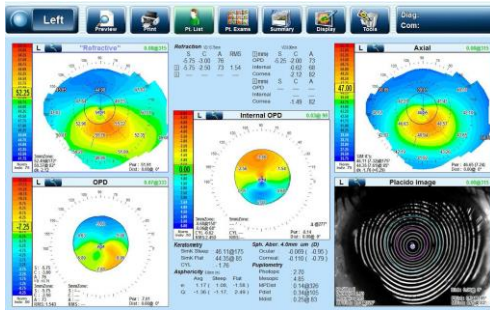
Patient B

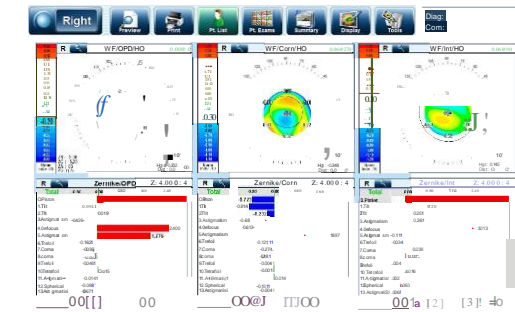
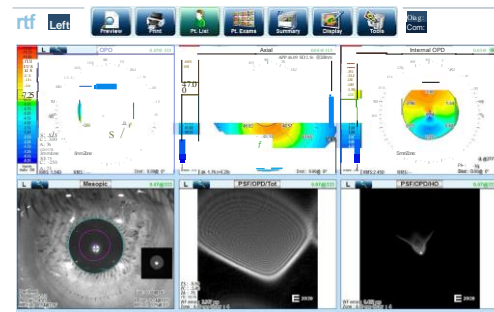
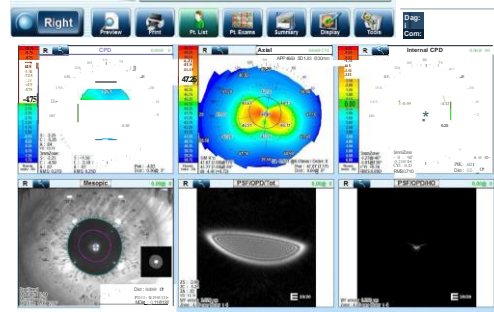
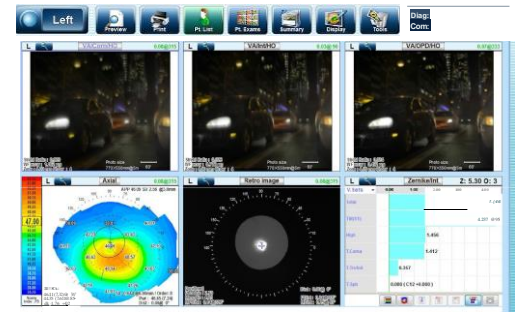
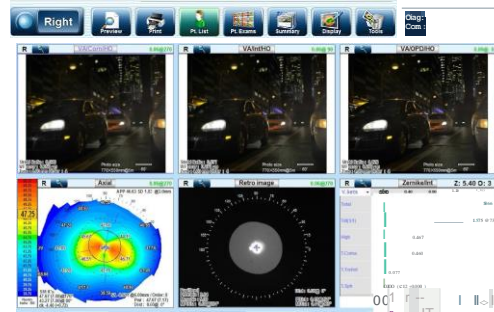
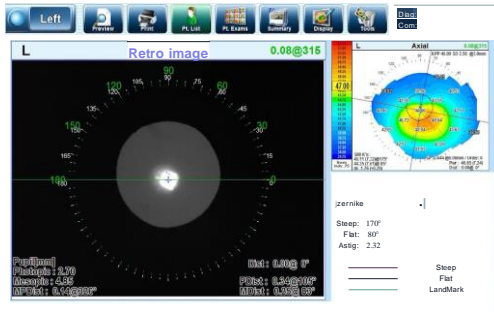
- 25 yr old Hispanic Male
- Wears glasses only
- Not interested in wearing contact lenses
- Best Corrected Distance VA OD 20/25; OS 20/25

Patient B

- 25 yr old Hispanic Male
- Wears glasses only
- Not interested in wearing contact lenses
- Best Corrected Distance VA OD 20/25; OS 20/25





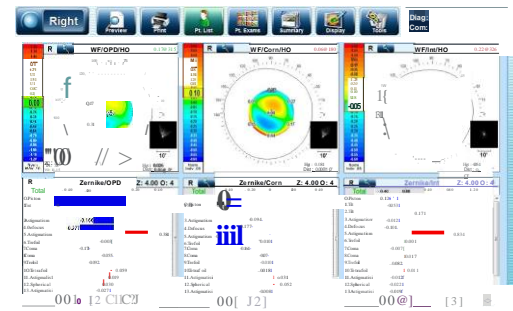
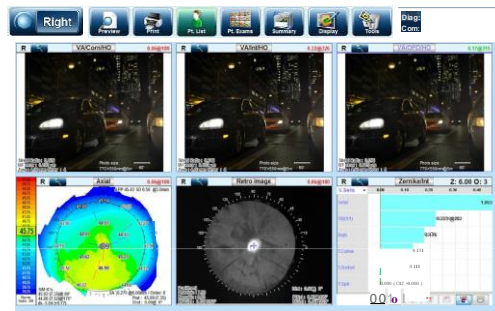
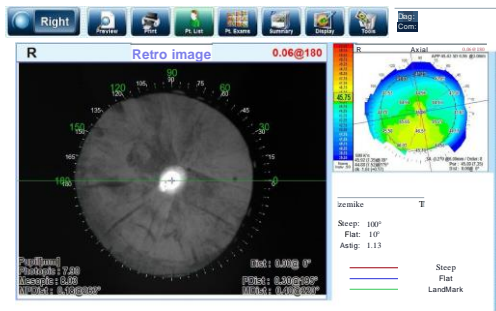
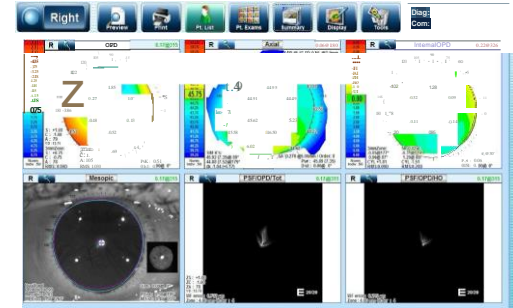


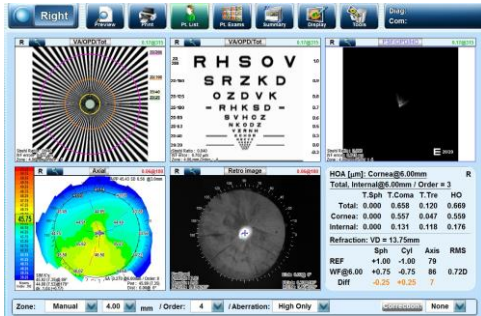
Patient B

- Keratoconus—A condition characterized by corneal thinning, protrusion, and irregularity. It is often bilateral and asymmetric in presentation. Etiology is sporadic or autosomal dominant with incomplete penetrance.
- Pellucid Marginal Degeneration—an uncommon bilateral condition with inferior corneal thinning, protrusion, and irregularity. Presents in early adulthood. Etiology is sporadic. Inferior crescent-shaped band of peripheral corneal thinning extending from 4 and 8 o'clock positions separated from limbus by normal cornea. Fleischer's ring and Vogt's striae are absent.

Patient C

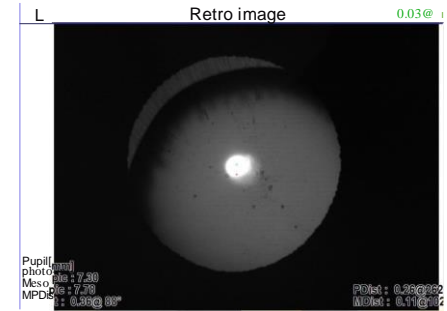
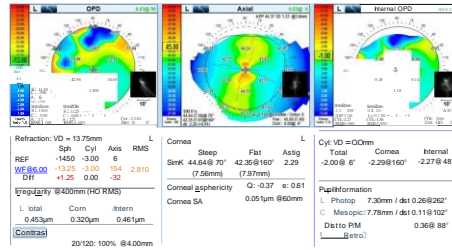
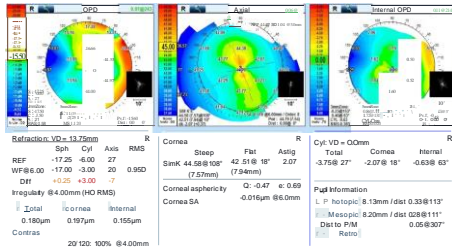
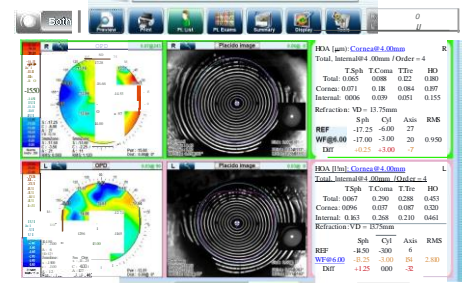
- 59 yr old AA Female
- Wears PAL's
- Drives mostly during the day time
- Best Corrected Distance VA OD 20/40; OS 20/40





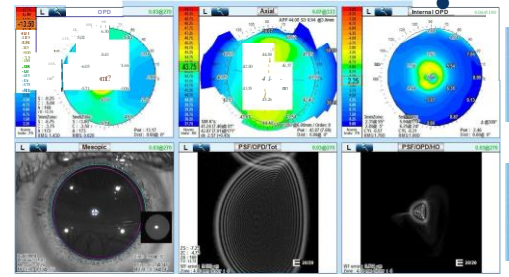
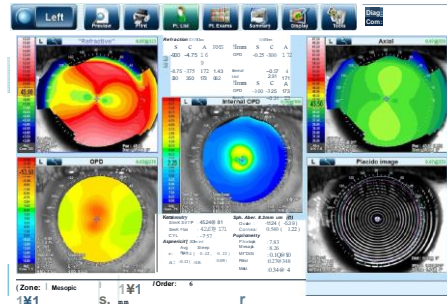
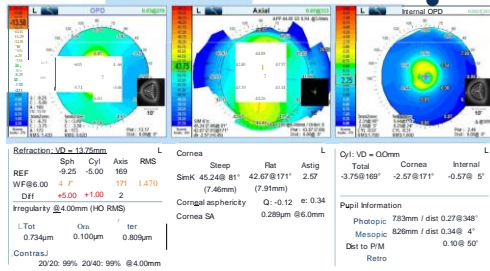
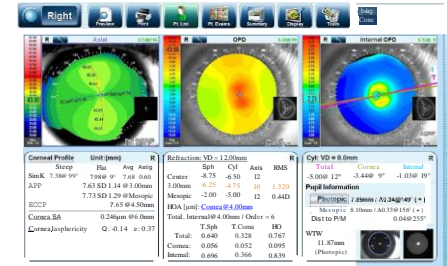
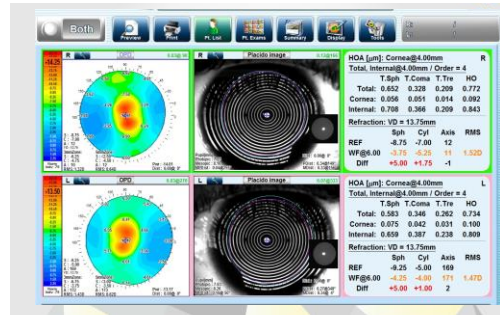
Patient C-1

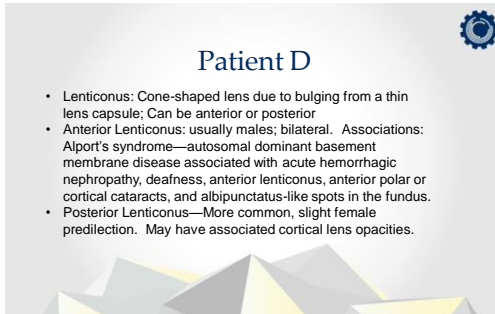
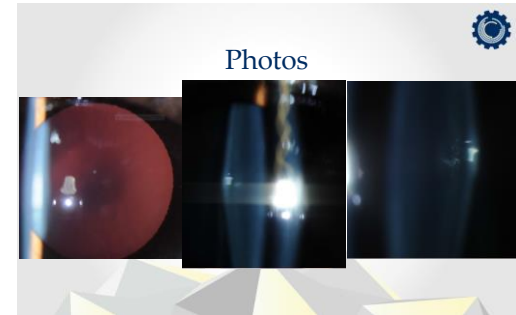
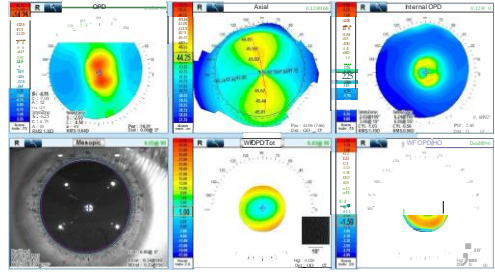
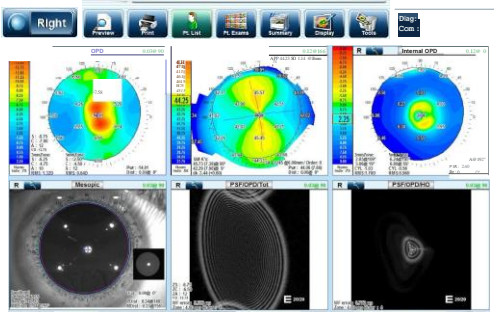
- 47 yr old AA Male
- Wears SV Specs
- Prison Guard—Wants Refractive Surgery
- Best Corrected Distance VA Specs OD 20/50; OS 20/50



Patient D

- 15 yr old AA Female
- Wears glasses but unhappy with Vision
- Uncorrected Distance VA OD 20/100; OS 20/100
- Best Corrected Distance VA OD 20/40; OS 20/40-





New and Emerging Technologies
Anterior Segment



ADENOPLUS
INFAMMADRY
TEARLAB
MEIBOGRAPHY
LIPIFLOW
BLEPHEX



AMNIOTIC MEMBRANES
ALCON/GOOGLE SMART LENS













AdenoPlus™ (RPS)

- × CLIA-waived Point-of-care Test
- × Detects all known serotypes of adenovirus
- × Rapid (~2mins to conduct, ~10mins for results)
- × One-time use
- × High sensitivity/specificity
- × Reimbursable; CPT Code: 87809
 - × "infectious agent antigen detection by immunoassay with direct optical observation, Adenovirus."
 - × CMS national limit: \$16.36




AdenoPlus™ (RPS)

- × Assemble detector with test cassette and sample collector
- × Dab patient's conjunctiva 4-6 times
- × Immerse detector with sample collector into buffer vial for 15sec
- × Positive results = both control line AND results line visible



InflammaDry™ (RPS)

- × CLIA-waived Point-of-care Test
- × Measures MMP-9 concentration in tear film; positive if >40 units/sample
- × Reimbursable; CPT Code: 83516
 - × "immunoassay for analyte other than infectious agent antibody or infectious agent antigen; qualitative or semi-quantitative, multiple step method."
 - × CMS national limit: \$15.74
- × Can be useful in dry eye diagnosis/management



TearLab™: Osmolarity

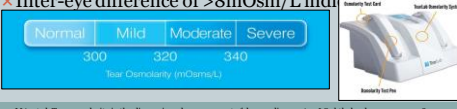
- × Osmolarity: proven biomarker of dry eye disease

Clinical Test	Criteria	PPV
Osmolarity	>317 mOsm/L	86%
Schirmer	<5mm/5min	31%
TBUT	<10sec	25%
Staining (RB)	Any	31%
Tear Meniscus	≤0.35mm	33%

- Dry Eye Workshop Study (DEWS): Report 5(2), April 2007.
- Tomlinson A, et al. Determination of a referent for dry eye diagnosis. Invest Ophthalmol Vis Sci 2006; 47(10).

TearLab™ Osmolarity


- × Determines tear osmolarity (mOsm/L) using tear fluid collected from eyelid margin
- × Osmolarity is indicator of ocular surface health
- × Osmolarity > 300mOsm/L: loss of homeostasis
- × Inter-eye difference of >8mOsm/L indicates



Lemp MA, et al. Tear osmolarity in the diagnosis and management of dry eye disease. Am J Ophthalmol 2011; 151:792-8.

BlephEx

- × Medical grade micro-sponge at end of electric rotary tool to exfoliate and remove scurf/debris from lid margin



Amniotic Membranes

- × Amniotic membrane: part of placenta
 - × Stem cell properties can aid in ocular surface repair
 - × Avascular
- × Prokera: symblypharon ring + CRYOTEK amniotic membrane
- × Treatment for a damaged ocular surface
 - × Chemical/thermal burns
 - × Stevens-Johnson syndrome
 - × Dry eye syndrome, exposure keratopathy
 - × Filamentary keratitis
 - × EBMD/RCE
 - × Other epithelial/BM degenerations
 - × Etc, etc...



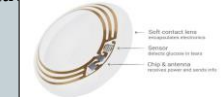
Amniotic Membranes

- × Natural growth factors
- × Prokera provides similar benefits to eye as amniotic membrane does to fetus:
 - × Physical barrier
 - × Anti-scarring
 - × Anti-inflammatory
 - × Anti-angiogenic
 - × Anti-adhesive
- × Facilitates tissue regeneration and growth
- × Active healing



Alcon (Novartis)-Google Partnership: Smart Lens

- × July 2014: partnership announced between Google[x] and Alcon to in-license –smart lens technology for all ocular medical uses.
- × DM: continuous blood [glucose] monitoring
- × Presbyopia: Accommodative contact lens



Smart Lens for Presbyopia

- × Smart Lens for presbyopia
 - × Photo diodes interact with light based on location of eyelid
 - × Wireless signal sent to liquid crystal embedded between two layers of contact lens
 - × Contact lens adjusts power for near or distance
- × Apply tech to accommodative IOLs?

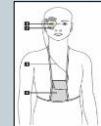
Alcon/Google: Smart Lens

- × Novartis CEO Joe Jimenez:
 - × "The calendar is on track and we are already developing a technological lens prototype (that) should be tested on humans in 2016.– (*Le Temps* (Swiss Newspaper), 5 Sep 2015)
 - × Anticipates product (smart lens for presbyopia) to market within 5 years



Sensimed AG: Triggerfish® Sensor Contact Lens

- × Soft hydrophilic contact lens that monitors eye pressure in glaucoma
 - × changes in corneal curvature may correspond directly to fluctuations in IOP
- × Data is transmitted wirelessly to a small adhesive antenna placed on the face near the eye
- × The antenna then transmits the data to a portable recorder worn by the patient
- × Can be worn continuously for one 24-hour period.
- × Data is transferred from the recorder to the doctor's computer via Bluetooth for immediate analysis.



ic100

- New design
- Enhanced Ergonomics
- Clinically robust
- Easy to use
- Accurate
- Precise



ic100 Features

- Improved forehead support
- EasyPos: New Positioning Assistant
- Improved forehead adjustment knob
- Large OLED Color Display
- EasyNav: New Navigation Interface
- New Ergonomic AMS Measure button



Icare® EasyPos: Intelligent Positioning Assistant



- Green light on the probe base indicates correct vertical alignment
- The probe should point perpendicularly to the center of the cornea (the reflection of the light ring is seen symmetrically inside the sphere of the pupil).
- Red light on the probe base indicates incorrect vertical alignment of the tonometer.

EasyNav: Advanced Navigation Interface

The advanced navigation interface includes 3 buttons and a 128x128 pixel OLED color display for effortless selection and menu browsing.




AMS: Automatic Measurement Sequence

Select between two modes:


Series mode: Press the measurement button for a sustained period of time (more than 2 seconds) and the tonometer will take six samples in rapid succession

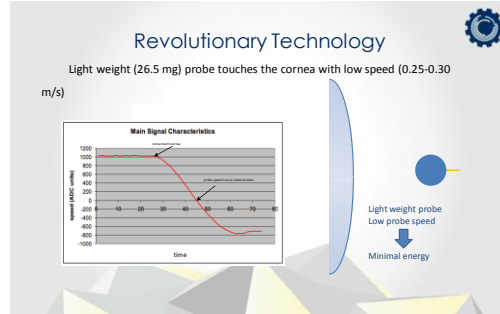
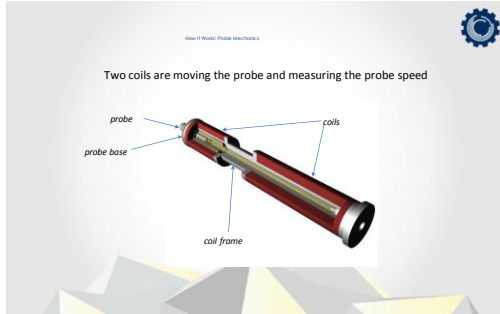
Single mode: In this mode, the measurement button must be pressed each time to initiate measurement (six samples = a complete measurement cycle)



Rebound Technology

- Easy-to-use
- Quick, effective routine barely noticeable by the patient
- Revolutionizes early glaucoma detection and control
- **No topical anaesthetics or disinfection needed**
- Disposable probe touches the cornea very lightly
- Suitable also for non-compliant patients and children
- Proven **accurate** by several independent studies
- Truly **portable**





- ### Measurement Basics
- The probe touches the cornea very gently
 - Measurement takes place in 0.1 seconds
 - Corneal reflex after 0.2 seconds
 - Measurement of motion parameters
 - To be repeated 6 times in order to minimize deviation and to produce a calculated measurement value
 - Whole procedure (6x both eyes) takes about one minute

Clinical Studies

REPRODUCIBILITY AND TOLERABILITY OF THE ICARE REBOUND TONOMETER IN SCHOOL CHILDREN
 "Measurement of intraocular pressure (IOP) with the rebound tonometer (RT) is a highly reproducible method in schoolchildren showing high intraobserver and interobserver correlation and it seems to be very comfortable when performing IOP measurements in schoolchildren without an anesthetic."
 Sahin A, Basmak H, Niyaz L, Yildirim N.
 J Glaucoma. 2007 Mar;16(2):185-9

AGREEMENT OF REBOUND TONOMETER IN MEASURING INTRAOCULAR PRESSURE WITH THREE TYPES OF APPLANATION TONOMETERS
 "iCare agrees well with applanation tonometers"
 Nakamura M, Darhad U, Tatsumi Y, Fujioka M, Kusuhara A, Maeda H, Negi A
 Am J Ophthalmol. 2006 Aug;142(2):332-4

- ### How Can We Gather This Data?
- Repeated, lab-based diurnal IOP readings over 24 hours
 An immense effort that is both flawed and impractical
 - Pressure sensors
 Invasive
 Expensive
 Limited
 Difficult to justify
 - Self monitoring
 Has to be accurate
 Has to be easy to use

- ### What is it?
- The iCare® HOME tonometer is a handheld, battery operated device that measures intraocular pressure (IOP) without the need for topical anesthetic.
 - The device is intended as an adjunct for monitoring IOP of adult patients (self-use) and also by caregivers in cases where the patient is not able to obtain their own measurements.
-

Why 24 Hr Monitoring?

24 hour IOP monitoring can reveal higher peaks and wider fluctuations of IOP than those found during routine office visits. Research reports a steady daily increase in IOP in some patients being treated for glaucoma.

□ Barkana Y, Anis S, Liebmann J, et al. Arch Ophthalmol. 2006;124:793-797.

Studies have shown IOP rises when a patient is supine; IOP peaks were measured upon awakening and declined within 30 minutes.

□ Barkana Y, Anis S, Liebmann J, et al. Arch Ophthalmol. 2006;124:793-797.

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Icare HOME tonometer

- IOP, date, time, eye recognition (right/left) and measurement quality are all stored in the internal memory.
- Data is transferred to a PC for further analysis by the prescribing physician.
- New features: positioning light, automatic eye recognition system, series or single measurements, new user interface panel.




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Icare® EyeSmart: Automatic Eye Recognition

The tonometer includes an automatic eye recognition system that identifies which eye is being measured.

- Two infrared LED transmitters below probe (1)
- One infrared LED sensor above probe (2)
- The infrared light is reflected from nose back to the sensor
- The sensor knows from which transmitter the reflected infrared light came from and thus which eye, right or left, was measured
- The resulting eye indication is stored into the memory of the tonometer




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Icare® AIG: Automatic Measurement Sequence

The tonometer can operate in two modes:

Series mode
Pressing the measurement button for a sustained period of time (more than 2 seconds) initiates the measurement function and the tonometer takes six measurements in rapid succession

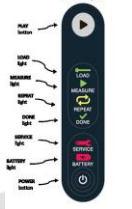
Single mode
The measurement button must be pressed each time to initiate the measurement, i.e. six samples for the whole measurement cycle



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New User Interface Panel

- Simple Indicator Lights and Audible Alerts
- Interpretation only by a health care professional
- Does not display the IOP measurement
 - Mitigating concerns that the patient or caregiver might improperly use the information provided by the device



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Icare® HOME Tonometer: Market Clearance

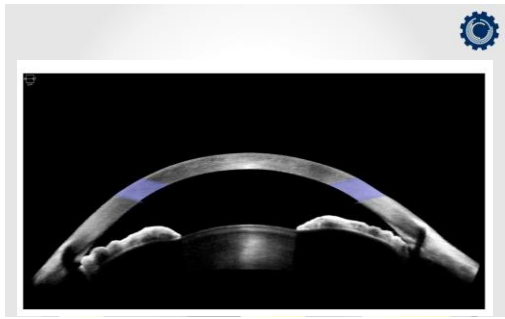
- USA: ????????
- Taiwan: November 2, 2015
- South Korea: June 18, 2015
- China: April 28, 2015
- Brazil: April 28, 2015
- Japan: October 29, 2014
- Canada: July 29, 2014



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Commercially available SD-

Spectral OCT/SLO iVue (Optovue) Spectralis (Heidelberg)



Potential applications:

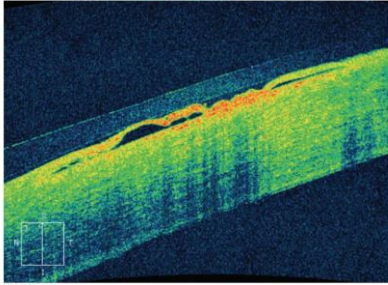
- ❖ Scleral lens fitting and evaluation
- ❖ Corneal pathology detection/management

Keratoconus

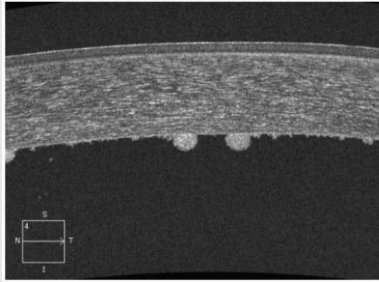
HSV Stromal Keratitis

- ① Scleral spur
- ② Schlemm's canal
- ③ Schwabbe's line

Bullous Keratopathy with BCL

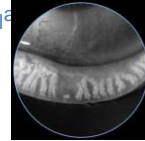


Keratic Precipitates



The Foundation For Ocular Surface Health

Meibomian Gland Function



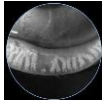
MGD: Prevalent, Progressive, Obstructive

MGD diagnosed in 86% of dry eye²
 Over 63% of cataract patients have dry eye symptoms³
 Over 30% of all patients > 50 years old have dry eye¹



CORE MECHANISM OF MGD IS GLAND OBSTRUCTION¹

[Function]



LEADS TO GLAND ATROPHY AND DROP OUT¹

[Structure]

1. Knox E, Knox N, Miller T, et al. The International workshop on meibomian gland dysfunction: report of the subcommittee on anatomy, physiology, pathophysiology of the meibomian glands. *Ocul* 2011;24(10):1038-1078.
 2. Lemp M, et al. Classification of meibomian gland and evaporative dry eye in a clinic-based patient cohort: a retrospective study. *Cornea* 2012;31(5):472-476.
 3. Tabbal WB, et al. Corneal and dry-eye. Prospective health assessment of cataract patients ocular surface study. Presented at ASCRS 2011, San Diego, CA.

Healthy Meibomian Gland Function is Foundational to Ocular Surface Health

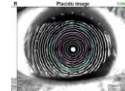


Early Intervention optimizes outcomes
 So Look for MGD EARLY

MGD Assessment requires the evaluation of gland function and/or structure

Blackie CA, Carlson AN, Korb DR. Treatment for meibomian gland dysfunction and dry eye symptoms with a single-dose vectored thermal pulsed laser. *Invest Ophthalmol Vis Sci* 2015;56(10):306-313.
 Blackie CA, Coleman CA, Holland EJ. The sustained effect (12 months) of a single-dose vectored thermal pulsed laser procedure for meibomian gland dysfunction and evaporative dry eye. *Clin Ophthalmol* 2015;9:1261-1268.

Unstable Ocular Surface Consequences Beyond Comfort



Tear film irregularities reduce retinal image quality by 20% to 40%. *Tut et al, 2000¹*

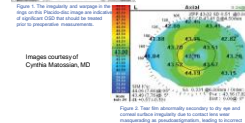


Figure 1. The irregularity and wavy nature of the tear film leads to errors in biometry and IOL power calculation. IOL power calculation is affected by the irregularity of the tear film. Images courtesy of Cynthia Matcosian, MD.

If not addressed, tear film dysfunctions can lead to errors in biometry and IOL power calculation. *Matcosian, MD*

Tear film irregularities induce significant higher order aberrations, symptoms of diplopia, starbursts, glare, and shadowing. *Marjan Farid, MD*

1. Rethelcke, et al. *Invest Ophthalmol Vis Sci* 2000;41:4117.
 2. The tear film: the neglected refractive interface. *Farid M. EyeWorld*. Supplement to EyeWorld 2014.

Rapid HD Meibomian Imaging

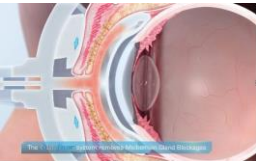


NEW

- Rapid image capture
- High definition Dynamic Meibomian Imaging (DMI™)
- User friendly
- Small footprint

Pretest workup imaging to fit workflow

LipiFlow® : Thermal Pulsation



- Inner-lid heat directed to Meibomian glands with Simultaneous Pulsation
- Cornea & Globe Protected
- Restores gland function
- In-office procedure ~12 mins

Only single dose treatment achieving long-term improvement in gland function & symptoms
 31 Sponsored/Un-sponsored Peer-reviewed studies & abstracts. Average improvement:
 ~3x Improvement in gland secretion
 ~Symptom score reduced 50%

1. Blackie CA, et al. Treatment for meibomian gland dysfunction and dry eye symptoms with a single-dose vectored thermal pulsation: a review. Current Opinion in Ophthalmology 2015; 26:306-313.

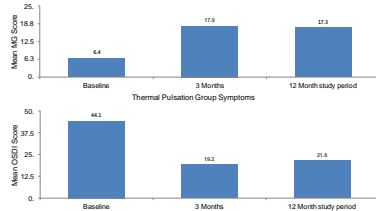
LipiFlow® Thermal Pulsation Pivotal Trial

Effectiveness Parameter	Summary	LIPIFLOW (n Site Study)	
		Baseline (N=130) Mean (SD)	4 Weeks (N=129) Mean (SD)
Meibomian Gland Secretions # Glands Secreting Any Liquid (0 to 15)	Tripled	1.9 (1.6)	5.8 (3.5)*
Tear Break-up Time (0 to 20 sec)	Improved - 40%	5.5 (2.9)	7.4 (5.5)*
Dry Eye Symptom Questionnaire Total SPEED Score (0 to 28)	Improved - 50%	14.3 (4.8)	7.6 (5.8)*
Total OSDI Score (0 to 100)	Improved - 50%	32.0 (20.0)	16.6 (18.1)*

15 OF 25 GLANDS STUDIED * p < 0.0001, change from baseline to 4 weeks

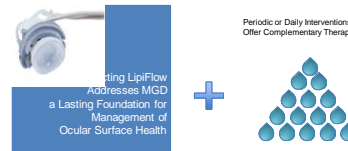
Line, et al. Cornea, 2012 LipiFlow for treatment of MGD Control Group: standardized warm compresses - 5 minutes, QD x 2w NO SIGNIFICANT IMPROVEMENT

The Long-Term Effect of a Single Dose LipiFlow Nine-center, Randomized Trial



* Blackie CA, Coleman CA, Holland EJ. The sustained effect (12 months) of a single-dose vectored thermal pulsation procedure for meibomian gland dysfunction and evaporative dry eye. Clin Ophthalmol. 2016;10:1385-1396.

LipiFlow® a Sustained Foundation



LipiFlow® Thermal Pulsation Results in Cataract and Contact Lens Patients

Impressive improvements in primary & secondary endpoints of gland secretion and ocular comfort from a single dose for three month study period

- Cataract patients with MGD
- Contact Lens patients with MGD and reduced wearing time

Registered randomized controlled trials, expected publishing late 2016

Manage the Ocular Surface

ASCRS Physician Survey 2013

—Eighty-eight percent agree or strongly agree that mild to moderate dry eye significantly affects postoperative satisfaction in cataract and refractive patients...ll

To optimize, maintain or rehabilitate the ocular surface healthy meibomian gland function is required*

*Buckle CA, Carlson AN, Korb DR. Treatment for meibomian gland dysfunction and dry eye symptoms with a single-dose vectorized thermal pulsation: a review. *Curr Opin Ophthalmol* 2015;26:306-313.

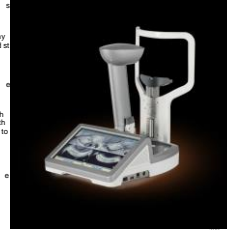
LipiScan® Indications For Use and Labeling & Risks

Indications for Use
LipiScan Dynamic Meibomian Imager (DMI) is an ophthalmic imaging device intended for use by a physician in adult patients to capture, archive, manipulate and display digital images of the meibomian glands.

Contraindications
No contraindications have been identified.

Precautions
Caution: Disinfect the surfaces of the chin rest, forehead rest and Handheld Near Infrared (IR) Lid Emitter with isopropyl alcohol immediately prior to use and prior to storage to prevent cross-contamination and patient infection.

Potential Adverse Effects
There are no known or anticipated adverse effects associated with use of this device.



LipiFlow® Indications For Use

Indications for Use

The LipiFlow® System is intended for the application of localized heat and pressure therapy in adult patients with chronic-cyclic conditions of the eyelids, including Meibomian Gland Dysfunction (MGD), also known as Evaporative Dry Eye or lipid deficiency Dry Eye.



Contraindications

Do not use the LipiFlow® System in patients with the following conditions: Ocular surgery, ocular injury, ocular herpes of eye or eyelid within prior 3 months
Active ocular infection or inflammation, or history of chronic, recurrent ocular inflammation within prior 3 months
Eyelid abnormalities that affect lid function
Eyelid abnormalities or ocular surface abnormalities that may affect/compromise corneal integrity or lid function

LipiFlow® Labeling and Risks

Precautions

- Severe (Grade 3 or 4) eyelid inflammation (eg, blepharochalasis, staphylococcal blepharitis, or seborrheic blepharitis). Patients with severe eyelid inflammation should be treated medically prior to device use.
- In addition, the treatment procedure may loosen previously inserted punctal plugs, which may worsen the patient's Dry Eye symptoms.

Potential Adverse Effects

- Eye/eye pain requiring discontinuation of the treatment procedure;
- Eye/eye irritation or inflammation (eg, edema, dermatitis, hordeolum or chalazion);
- Ocular surface irritation or inflammation (eg, corneal abrasion, conjunctival edema, or conjunctival injection (hyperemia)); and
- Ocular symptoms (eg, burning, stinging, tearing, itching, discharge, redness, foreign body sensation, visual disturbance, sensitivity to light).
- Potential serious adverse events that are not anticipated because of the device mitigations to prevent occurrence include:
 - Thermal injury to the eyelid or eye, including conjunctiva, cornea or lens;
 - Physical pressure-induced injury to the eyelid;
 - Ocular surface infection.

Dynamic Meibomian Imaging (DMI)

The LipiView® II with DMI employs two novel imaging technologies: Dynamic Illumination and Adaptive Transillumination. Each technology generates its own independent image of the glands which is then processed, displayed and combined to provide a more accurate visualization of meibomian gland structure.



Raising the bar: Using Metrics



- All MGD goes through a 3-phase process.
- The earliest intervene early in the disease process if we are not looking for MGD.
- Any compromise to gland function and/or structure is an indication to consider therapeutic intervention
- If we are not looking for it, we will miss it!

Meibomian Gland Morphology

Normal Meibomian gland structure

Gland truncation

Gland drop out

LipiView® II: Adaptive Transillumination

Changes the light intensity across the surface of the illuminator to compensate for lid thickness variations between patients

Meibomian Gland Evaluator (MGE™)

The number of FUNCTIONAL Meibomian Glands correlates with dry eye symptoms

	Severe Symptoms	Moderate Symptoms	Minimal Symptoms	Asymptomatic healthy eyes ¹ (n = 24 glands)
Symptom Score (MDEQ 20-30)	9.5 (8.4 to 9.7)	6.9 (5.3 to 8.2)	3.5 (2.3 to 4.2)	0
Number of functional MGs for lower eyelid	4.1 ± 0.6	5.1 ± 0.4	6.3 ± 0.4	10.6 ± 2.6

FUNCTIONAL MGs in the Lower Lid

0 4 5 6 7 8 9 10+

DRY NOT DRY

4-6: treatment necessary; 0-3 glands present
5-6: intervention lightly advised
7-9: preventive treatment (PTMG)

A Change in Philosophy – MGD First

Dry Eye Approach

- Wait for the onset of sequelae: The patient tells you there is a problem
- Measure and manage dry eye sequelae
- Lead with palliative artificial tears
- Gradually advance treatment as sequelae increase in severity^{1,2}

Goal: Treat Sequelae (primarily symptoms)

- Root cause is not identified: Promotes confusion, and patient despair

MGD First/Root Cause Approach

- Evaluate everyone for MGD: Identify MGD at its earliest stages
- Educate patients about the front line of defense of the tear film – the lipid layer
- Offer the most efficacious MGD treatment as early as possible
- Rehabilitate the ocular surface and manage sequelae with adjunctive therapy

Goal: Restore and optimize gland function/ intervene in progression

- Promotes patient and physician confidence in MGD management.

Examples of meibum stagnation and changes that correspond to MGD

Clear liquid secretion (glands are functional using the MGE)

Cloudy liquid secretion (glands are functional using the MGE)

Opaque solid secretion (glands not functional; requires more force than the MGE)

Absence of secretion (glands not functional; even significant force does not yield secretion)

Notching at gland orifice (indicates desquamation)

Educate your patients about MGD

MeiboGrade | MGD is measured by functional Meibomian gland structure on the eyelids.

MEIBO GRADE SCORE

10+ 9-7 6-4 3-1

10+ Meibomian Gland Structure (MGS) is normal

9-7 Meibomian Gland Structure (MGS) is slightly abnormal

6-4 Meibomian Gland Structure (MGS) is moderately abnormal

3-1 Meibomian Gland Structure (MGS) is severely abnormal

LIPID LAYER THICKNESS

10+ Meibomian Gland Structure (MGS) is normal

9-7 Meibomian Gland Structure (MGS) is slightly abnormal

6-4 Meibomian Gland Structure (MGS) is moderately abnormal

3-1 Meibomian Gland Structure (MGS) is severely abnormal

GLAND FUNCTION

10+ Meibomian Gland Structure (MGS) is normal

9-7 Meibomian Gland Structure (MGS) is slightly abnormal

6-4 Meibomian Gland Structure (MGS) is moderately abnormal

3-1 Meibomian Gland Structure (MGS) is severely abnormal

Progressive Compromise to Gland Structure Indicates Chronic MGD

Meibomian Gland Structure (MGS) is normal

Meibomian Gland Structure (MGS) is slightly abnormal

Meibomian Gland Structure (MGS) is moderately abnormal

Meibomian Gland Structure (MGS) is severely abnormal

Compromise to Gland Structure Indicates Chronic MGD and Reduced Gland Function

Core Therapy: Remove obstruction

Novel Approach:
Heat the inner lid surface with simultaneous gland evacuation

Safe, effective, precise, proven:

- Restores Meibomian Gland function
- Applies a combination of heat and pressure directly to the inner eyelid
- FDA-cleared and clinically approved
- Independent proven results in peer-reviewed studies 1-3

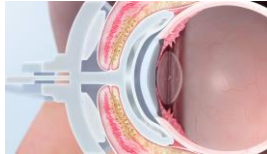
Therapeutic Effect: Controlled energy heats internal meibomian and part of healthy and diseased tarsal plate, causing the lipid secretions to clear meibomian orifice from the gland.

Feedback Control System: Real-time monitoring of eyelid temperature, gland cavity depth and energy.

Control Panel: Covers eye, maintains position. Eye position, time remaining, and 100% gland evaporation energy are displayed. Gland cavity depth and energy are displayed. Gland cavity depth and energy are displayed.

Flare Equilibration: protects the patient from thermal damage to the eyelid.

LipiFlow® Thermal Pulsation



LipiFlow® is the only FDA-cleared device for Meibomian Gland Dysfunction (MGD), shown to restore gland function.

LipiFlow® is an in-office procedure, taking only 12 minutes per eye.



Identify and Detect MGD

Safely and Effectively Treat MGD

Keratoconus

- Keratoconus: first described in detail in 1854 as a chronic, non-inflammatory ectasia of the cornea.
- Annual Incidence of 2 per 100,000
- Prevalence of 54.5 per 100,000
- No universally recognized classification system
- The Amsler-Krumeich is one of the oldest and most widely used classification system grading KC from stage 1-4 using spectacle refraction, central keratometry, presence of absence of scarring and central corneal thickness (CCT)

Keratoconus

- Global Consensus on KC and Ectatic Diseases (2015) reports there is no consistent or clear definition of ectasia progression
- Kmax (maximum anterior sagittal curvature) is the most commonly used parameter to detect or document ectatic progression and is regularly used as an indicator of crosslinking's efficacy
- The —Belin ABCDII KC Grading system uses anterior and posterior radius of curvature taken from the 3 mm zone centered on the thinnest point (A for Anterior, B for Back Surface, C for Corneal thickness, and D for Distance Visual Acuity.

Belin ABCD System in Oculus Pentacam

Parameter	Value	Normal Range	Unit
ABCDII	1	1-4	Grading
Anterior Radius	7.50	7.50-8.50	mm
Posterior Radius	6.50	6.50-7.50	mm
Central Thickness	540	540-560	µm
Distance Visual Acuity	20/20	20/20-20/40	Snellen

CORNEAL COLLAGEN CROSS LINKING

Epithelium, Stromata, Cornea, Dextran 20, Riboflavin B2, Ultraviolet A

The Principle

Before cross-linking: Disorganized collagen fibers. After cross-linking: Strengthened collagen fibers.

Before cross-linking: Disorganized collagen fibers. After cross-linking: Strengthened collagen fibers.

Corneal Cross-Linking

- × Liquid riboflavin (Vit B2) applied to surface of eye, followed by controlled application of UV light
- × Goal is to *prevent progression* of ectasia by increasing number of cross-linking bonds in stroma
- × **Ideal candidate**
 - × Young patient with early KCN showing progression
 - × Thinnest pach no thinner than 300 μm

Corneal Cross-Linking

- × Central 7-9mm of epithelium removed
- × Riboflavin B2 in 20% Dextran applied every 5 minutes, while UVA (365-370nm) applied for 30min
- × Typical post-op: bandage CL + topical antibiotics/steroids x2-4wks
 - × Cornea thins slightly after CXL (mean change 2.4 μm), but return to baseline in 1yr
 - × Corneal K's ↓ ~2D after 2yrs
- × Combine with Intacs to improve VA?

Cipriani LA, Mazzotta C, Baiocchi R, Cipriani T. Long term results of riboflavin ultraviolet A corneal collagen cross-linking for keratoconus in Italy: The Siena Eye Cross Study. Asia J Ophthalmol 2016; 14(4): 498-501



The US Food and Drug Administration (FDA) has approved a riboflavin ophthalmic solution (*Photrexa, Avedro*) that treats a corneal disease called progressive keratoconus with corneal collagen crosslinking, the manufacturer announced today.

The approval extends to a version of the **riboflavin ophthalmic solution** that contains dextran (*Photrexa Viscous*) and an electronic device (*KXL System*) that irradiates the solutions with ultraviolet A light after they have been applied to the cornea.

Collagen Cross Linking

OCULUS - PENTACAM Topometric / KC Staging

Left Eye (OD) and Right Eye (OS) charts showing keratometry and topography. Includes data for keratometry (K1, K2, K3, K4, K5, K6), astigmatism, and corneal thickness.

OCULUS Optometric GmbH, 35562 Wetzlar, Tel: (0641) 20 95 5, Fax: (0641) 20 95 255, www.oculus.de

Collagen Cross Linking

CONTRAINDICATIONS

- Pachymetry less than 400 microns, with some exceptions
- Prior herpetic infection
- Current infection
- History of poor epithelial wound healing
- Severe ocular surface disease
- Autoimmune disorders
- Significant corneal scarring
- RGPs no longer provide reasonable vision

RECOVERY

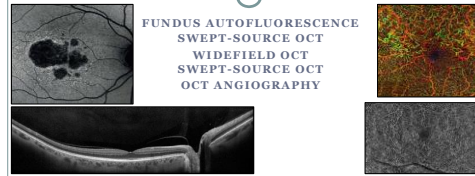
- Similar to PRK
- Topical NSAID and prescriptive oral pain medication prescribed to improve comfort

Ancillary Techniques in Tx of Microbial Keratitis



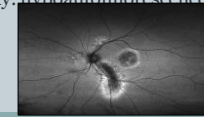
- Topical Corticosteroids
- Collagen-Cross Linking (CXL)—PACK-CXL or photoactivated chromophore for infectious keratitis—Experimental
- Intrastromal Antimicrobials
- Amniotic Membrane Transplantation
- IVP for Acanthamoeba

New and Emerging Technologies Posterior Segment



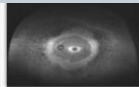
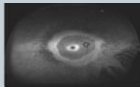
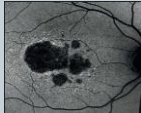
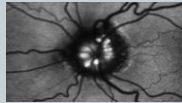
Fundus Autofluorescence (FAF)

- × Non-invasive imaging modality using cSLO
- × Pictorial representation of metabolic activity
 - × High activity: hyperautofluorescence
 - × Low activity: hypoautofluorescence



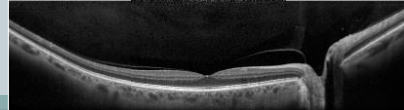
Fundus Autofluorescence (FAF)

- × ONH Drusen
- × Retinal degenerations



Widefield OCT (*Heidelberg Engineering*)

- × Current field of view with SD-OCT: 30°
- × Spectralis OCT with widefield module: 55°
- × Macula, ONH and periphery in one examination
- × Widefield lens attachment + software upgrade to current Spectralis OCT

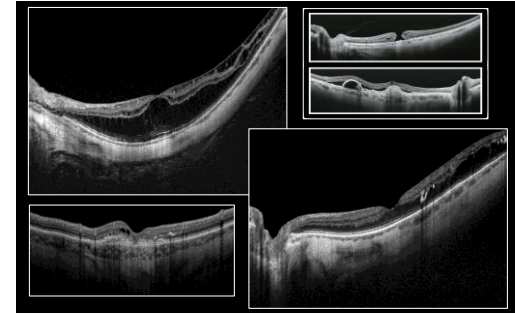
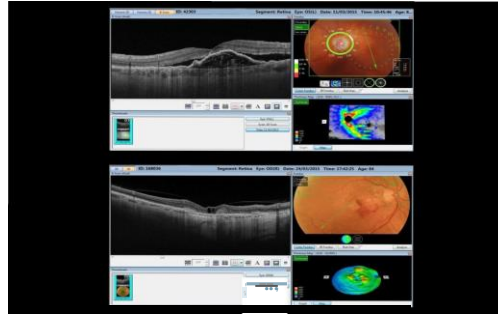
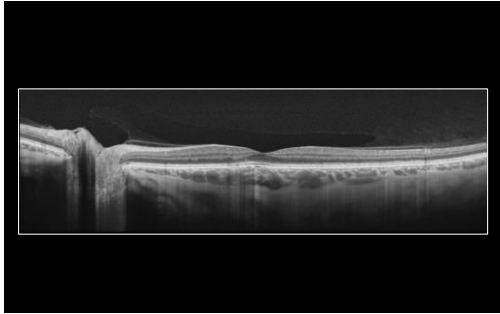


Swept-Source OCT (SS-OCT)

- × Visualization of choroid (deeper)
- × Faster scan rate (*and 4 wider field width*)
- × Equal/higher resolution to SD-OCT

	TD-OCT	SD-OCT	SS-OCT
Scan Rate (A-Scans/sec)	400	27,000-50,000	up to 1,000,000
Resolution	10-15 / m	3 / m axial	1-3 / m
B Scan Field Width	6-9mm	6-9mm	12mm

- × Zeiss and Heidelberg: prototypes
- × Topcon: DRI Triton OCT



OCT Angiography (OCTA)

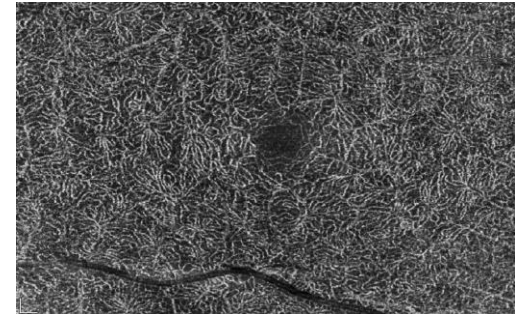
- × Isolation/extraction of microvascular circulation from OCT image data using specialized processing techniques
- × Visualization of ALL vascular layers without dye injection
 - ✦ FA does NOT image radial periphery or deep capillary networks well
- × Moving structures: phase shift/phase-doppler
 - ✦ after eliminating excess motion artifacts, residual motion = blood flow

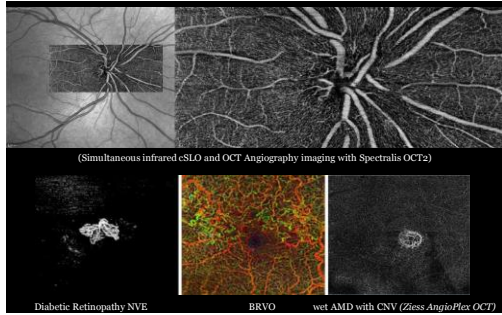
• Spaide RF, Klancnik JM Jr, Cooney MJ. Retinal vascular layers imaged by fluorescein angiography and optical coherence tomography angiography. *JAMA Ophthalmol* 2015; 133(1):45-50.

OCT Angiography (OCTA)

- × Sequential B-Scans performed repeatedly at same location in the retina to detect motion of scattering particles (e.g Layer-by-layer analysis of vascular anatomy)
- × AngioVue (*Optovue*)
- × Cirrus HD-OCT with AngioPlex (*Zeiss*)
- × Spectralis OCT Angiography (*Heidelberg Eng.*)

• Spaide RF, Klancnik JM Jr, Cooney MJ. Retinal vascular layers imaged by fluorescein angiography and optical coherence tomography angiography. *JAMA Ophthalmol* 2015; 133(1):45-50.





Zeiss AngioPlex Maps

- × 2D representation of retinal vasculature in a particular region of interest

Superficial Retina Map

Visualization of blood flow in superficial retina.

Deep Retina Map

Visualization of blood flow in deep retina.

Avascular Retina Map

Avascular region of the retina in healthy eyes allows for detection of abnormal vascular growth.

Zeiss AngioPlex Maps

- × Color depth map combines superficial, deep and avascular retina maps and allows for depth visualization of retinal blood flow

Color Depth Retina Map

Superficial Retina

Deep Retina

Avascular Retina

Potential Clinical Applications

- × Detection of:
 - × CNV
 - × Neovascularization in Macular Telangiectasias
 - × MA's and ischemia in Diabetic Retinopathy
 - × Oclusions, shunts and other abnormalities in RVO's
 - × ONH Vasculature abnormalities

OCT Angiography (OCTA) Limitations

- × No supportive clinical trial data yet
- × Interpretation of *en-face* images depends on accurate segmentation
- × Loss of sensitivity with depth
 - × Swept Source OCT may address this
- × Cost?

• Spaide RF, Klancnik JM Jr, Cooney MJ. Retinal vascular layers imaged by fluorescein angiography and optical coherence tomography angiography. JAMA Ophthalmol 2015; 133(1):45-50.

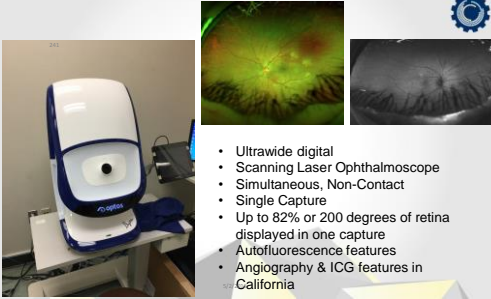
Confocal Imaging Systems

Confocality brings better images

- Confocal systems (such as SLOs) eliminate reflection from layers that are far from the focal plane

Confocality:

- improves resolution and local contrast
- reduces the impact of cataract and corneal opacities
- Works with much smaller pupil than conventional fundus cameras
- reduces optic disc bleaching



- Ultrawide digital
- Scanning Laser Ophthalmoscope
- Simultaneous, Non-Contact
- Single Capture
- Up to 82% or 200 degrees of retina displayed in one capture
- Autofluorescence features
- Angiography & ICG features in California

Centervue Eidon



Benefits

- True color, Red Free and Infrared confocal images
- Super-high resolution and contrast
- Capability to image through cataract and media opacities
- Dilation-free operation (minimum pupil 2.5 mm)
- Wide Field Imaging (60° in single exposure and up to 150° with Mosaic function)
- Optimal exposure of the optic disc
- Exam time less than 1' per eye (single field)
- From Fully automated to Fully manual mode
- User friendly software interface


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- User friendly software interface

Centervue Compass



Benefits

- High-resolution TrueColor Confocal Imaging of the ONH, of the RNH, and of central retina
- Combined structure and function analysis
- High test - retest repeatability thanks to the Real Time Retinal Tracking, that actively compensates eye movements
- Reliable automated follow up with combined structure-function progression analysis
- Comprehensive printout
- Operator friendly: no trials lens required, automatic refractive correction
- More patient comfort: test can be suspended at any time without data loss

Centervue Compass

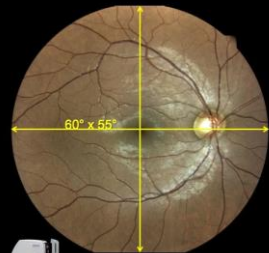


Compass is the first Fundus Automated perimeter capable of performing standard 24-2 visual field testing, delivering TrueColor confocal images at the same time.

COMPASS is a scanning ophthalmoscope combined with an automatic perimeter that provides confocal images of the retina, as well as measurements of retinal threshold sensitivity, under non-mydiatic conditions.

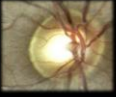
SPECIFICATIONS

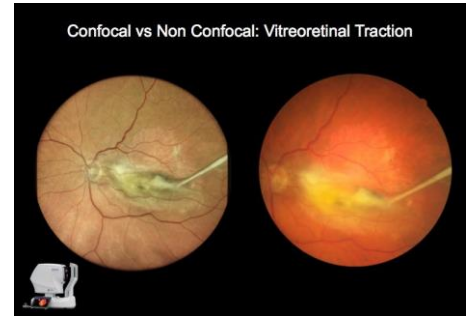
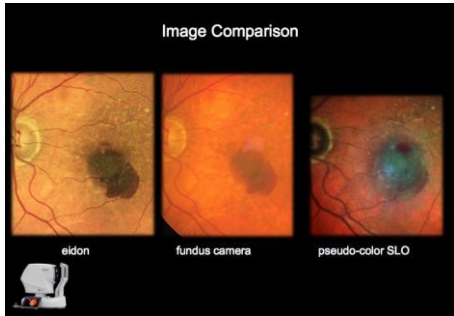
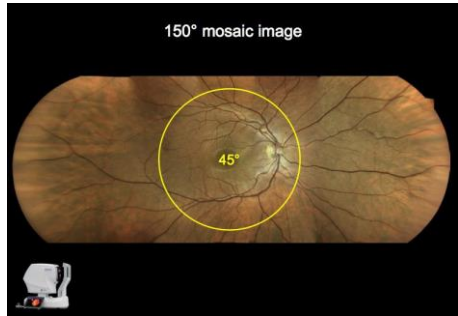
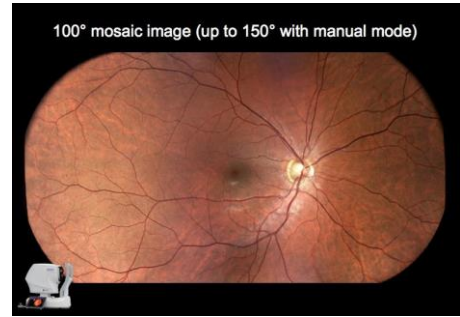
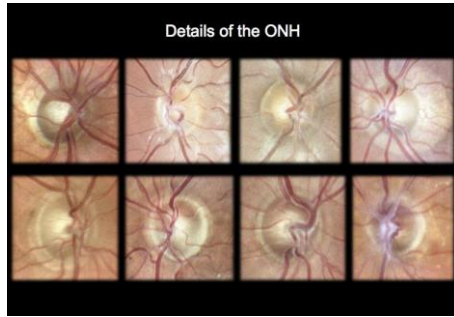
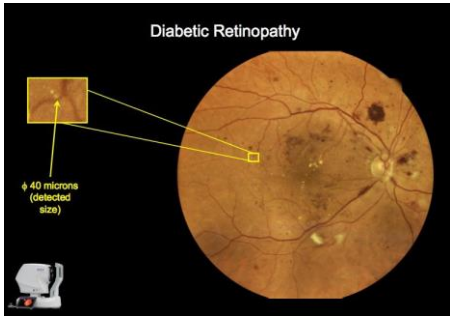
Eidon



60° x 55°

Detail: 10°







Centervue—Superior Wide Field Image Quality with Small Pupil Size

Eidon with AF: <https://youtu.be/5B1qtu6tdMg>

Compass: https://youtu.be/m_zP7V9_wQQ

...

Introduction

There are layers of the retina that we simply can't see with traditional fundus examination and photographic means...

The Vitreomacular Interface

The RPE

The Choroid

Multi-Spectral Imaging (MSI) with the Annidis RHA™ provides access to these layers.

Multi-Spectral Imaging (MSI)

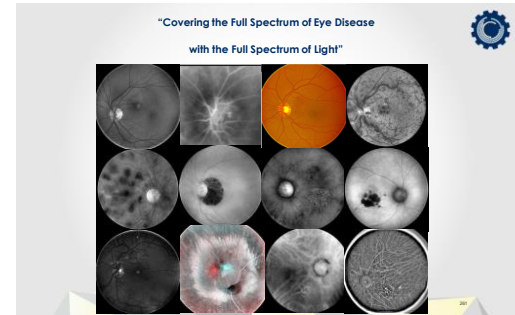
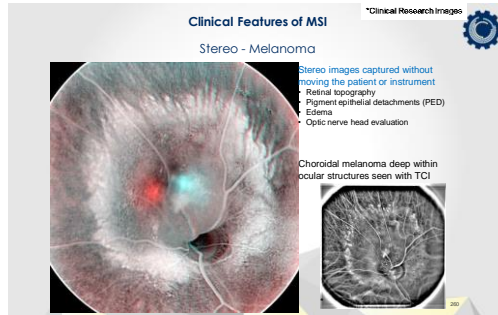
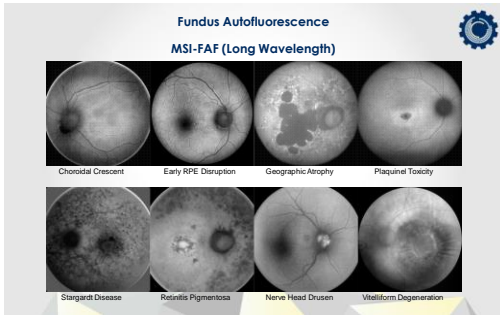
- Annidis RHA™ Multi-Spectral Imaging is emerging as the most comprehensive technology for the early detection of outer retinal and choroidal disorders, including all forms of AMD and opening a new frontier in non-invasive ocular imaging—
- Discrete narrow band light emitting diodes (LEDs) are used to create a series of non-invasive en face –spectral images throughout the entire thickness of the retina and choroid
- Provides an enhanced view of the entire retinal and choroidal architecture including the RPE

The Annidis RHA™

Discrete monochromatic LED lights are used to create a series of en face –spectral images throughout the entire thickness of the retina and choroid including the RPE.

The Benefits of MSI

- Detect more pathology
- Identify pathology earlier
- Screen for change more frequently
- Utilize the Dry/Dexy retinal and choroidal images as a form of proactive multi-spectral angiography
- Make sure that your ophthalmological referrals are pertinent
- Monitor the effectiveness of treatment
- Engage your patients with this technology by teaching them the value of assessing all of structures and layers of their retina and choroid



New and Emerging Pharmacological Agents

XIIDRA
GENERIC OCULAR HYPOTENSIVES
LATANOPROSTENE BUNOD
RHOPRESSA
ROCLATAN
BIMATORPROST SUSTAINED RELEASE

aerie

Xiidra™ (lifitegrast 5% oph soln)

Shire


Xiidra™ (lifitegrast 5% oph soln)

- ✗ Lymphocyte [CD4 T-Helper Cell] Function-associated Antigen-1 (LFA-1) antagonist
- ✗ Activated CD4 T-Cells release cytokines, exacerbating inflammation
- ✗ Lifitegrast blocks the binding of CD4 T-Cells, preventing their activation
- ✗ may block initiation of inflammatory cascade

Figure 1 Immunologic synapse.
 Notice: LFA-1 on the surface of T-cell binds with ICAM-1 expressed on APC allowing interaction of TCR with MHC.
 Abbreviations: APC, antigen-presenting cell; ICAM-1, intercellular adhesion molecule-1; LFA-1, lymphocyte function-associated antigen-1; MHC, major histocompatibility complex; TCR, T-cell receptor.

Xiidra™ (lifitegrast 5% oph soln)

- Received FDA approval July 11, 2016
- Indication:
 - For the treatment of the signs and symptoms of dry eye disease
- Dosage: 1gtt BID
- Packaged in single-use, non-preserved vials

Xiidra™ (lifitegrast 5% oph soln)

- OPUS-1 Trial**
 - Significantly reduced corneal fluorescein and conjunctival lissamine green staining vs placebo after 84 days
 - Improvements noted by day 14, persisted through day 84
 - Significant improvements in subjective measures of ocular discomfort and eye dryness but not as measured on standardized surveys (VR-OSDI) as in Phase 2 trials
 - Adverse events reported
 - Discomfort on instillation at start of Tx = 24%

—Lifitegrast ophthalmic solution 5% versus placebo for treatment of dry eye disease: Results of the OPUS-1 phase 3 study Sheppard JD, Torkildsen GL, Lonsdale JD, et al. Ophthalmology. 2014; 121:475-483.

Xiidra™ (lifitegrast 5% oph soln)

- OPUS-2 Trial**
 - Significant improvement in eye dryness as reported using a visual analog scale as early as 14 days improving through days 42 to 84
 - No changes demonstrated in decreasing corneal and conjunctival staining
 - Adverse events reported:
 - Burning on instillation = 28%
 - Dysgeusia (change in taste sensation) = 19%

—Lifitegrast ophthalmic solution 5% versus placebo for treatment of dry eye disease: Results of the randomized phase 2 OPUS-2 study. Sheppard JD, Torkildsen GL, Lonsdale JD, et al. Ophthalmology. 2015; 122:2423-2431.


Xiidra™ (lifitegrast 5% oph soln)

- Where does it fit in our treatment plan?
- Designed as a chronic therapy
- Insurance coverage?




Xiidra™ - Pearls

- Keep unused vials in foil sleeve
 - Light sensitive - will turn yellow and spoil
- Safety not established <17 years of age
- FDA no longer assigns pregnancy categories
 - Safe in rat models
 - Use professional judgement prescribing for pregnant patients
- Wait 15 minutes after instillation before inserting CLs
- Use punctal occlusion with fingers/tissue and head tilt forward after instillation to keep from running down back of throat to avoid dysgeusia



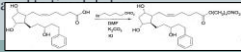
Generic Ocular Hypotensives to Market

- Generic Lumigan: bimatoprost 0.03% oph soln**
 - Lupin Pharmaceuticals (Baltimore, MD)
 - FDA-Approved Feb 23, 2016
- Generic Travatan: travoprost 0.004% oph soln**
 - APOTEX INC
 - FDA-Approved July 10, 2016



Latanoprostene bunod

- × = latanoprost + a -Nitric Oxide donating moiety
- ✦ Nitric Oxide: vasodilator via action on smooth muscle
 - Also suppresses Rho signaling pathway
 - TM cells and tissue relax, decreasing outflow resistance
- ✦ Currently in Phase 3 Clinical Trials
- ✦ Two phase 3 clinical trials (APOLLO, LUNAR) already have shown latanoprostene bunod 1gtt qHS had higher IOP-lowering effect compared to latanoprost

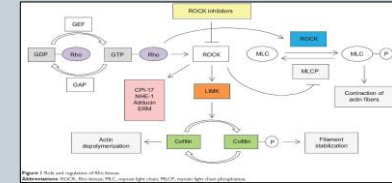


Rhopressa™ (netarsudil 0.02% oph soln)

- ✦ Rho-Kinase (ROCK) and Norepinephrine Transporter (NET) Inhibitor
- ✦ Also lowers episcleral venous pressure
- ✦ Possible anti-fibrotic effect on TM
- ✦ Research underway to evaluate possible neuroprotective effects
- ✦ Currently in Phase 3 Clinical Trials



ROCK Inhibitors: Mechanism of Action



(Inhibition of actin cytoskeleton contractile tone of TM smooth muscle)

Roclatan™ (netarsudil/latanoprost 0.02/0.005% oph soln)

- ✦ Phase 3 Trials COMPLETE 9/14/2016



Roclatan™ (netarsudil/latanoprost 0.02/0.005% oph soln)

- ✦ Efficacy:
- ✦ IOP lowering exceeded latanoprost by 1.3 to 2.5mmHg
- ✦ IOP lowering exceeded Rhopressa™ by 1.8 to 3.0mmHg



Roclatan™ (netarsudil/latanoprost 0.02/0.005% oph soln)

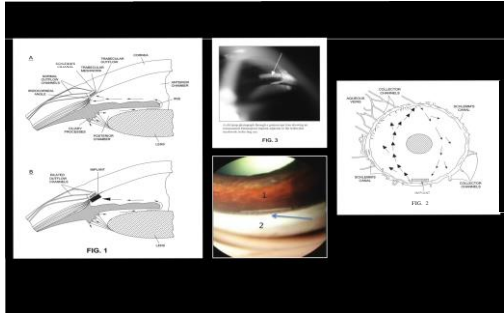
Adverse Events (≥5.0% in any group)	Roclatan™ n=238	Rhopressa™ n=244	Latanoprost n=236
Eye Disorders			
Conjunctival Hyperemia	126 (52.9%)	99 (40.6%)	33 (14.0%)
Conjunctival Hemorrhage	25 (10.5%)	34 (13.9%)	1 (0.4%)
Eye Pruritus	18 (7.6%)	17 (7.0%)	3 (1.3%)
Lacrimation Increased	14 (5.9%)	15 (6.1%)	1 (0.4%)
Cornea Verticillata	12 (5.0%)	9 (3.7%)	0 (0.0%)
Administration Site Conditions			
Instillation site pain	45 (18.9%)	51 (20.9%)	15 (6.4%)

Roclatan™ (netarsudil/latanoprost 0.02/0.005% oph soln)

	Roclatan™ N = 226	Flupressa™ N = 244	Latanoprost N = 206
Completed Month 3	201 (84.5%)	201 (82.4%)	223 (94.5%)
Discontinued Prior to Month 3	37 (15.5%)	43 (17.6%)	13 (5.5%)
Reasons for Discontinuation			
Adverse Event	25 (10.5%)	23 (9.4%)	0
Withdrawal of Consent	4 (1.7%)	4 (1.6%)	4 (1.7%)
Non-Compliant	0	1 (0.4%)	1 (0.4%)
Lost to Follow-up	1 (0.4%)	3 (1.2%)	1 (0.4%)
Lack of Efficacy	0	5 (2.0%)	1 (0.4%)
Disallowed Concurrent Medication	1 (0.4%)	4 (1.6%)	1 (0.4%)
Investigator Decision	2 (0.8%)	0	0
Protocol Violation	4 (1.7%)	1 (0.4%)	5 (2.1%)
Other	0	2 (0.8%)	0

Bimatoprost Sustained-Release Implants

- × Device asymmetrically swells then shrinks to ~ sphere then disappears between 4-6 mo
- × Doses: 6, 10, 15, 20 micro grams
- × 91% reached clinical endpoint @ week 16
- × 41% @ 6 months
- × 10% hyperemia

Bimatoprost Sustained-Release Implant is a Significant Global Opportunity

Bimatoprost Sustained-Release Implant is a Significant Innovation

- A sustained-release, prostamide-loaded, bioreabsorbable implant
- Injected into the anterior chamber
- Can be performed in the office
- Ensures patient compliance
- Disruptive, first-in-class technology
- Data from Phase 2 clinical trials suggest that bimatoprost sustained-release implant efficacy is comparable to daily topical bimatoprost with duration of 4-6 months

Noncompliance an Issue with Current Treatment

- Inability to correctly and reliably instill eye drops (10%)
- Adverse effects associated with taking eye drops
- The number of medication and the complexity of the dosing schedule (10%)
- Understanding of glaucoma including the consequences and its treatment (10%)
- Medication cost (10%)
- Patient forgetfulness (10%)

20% of Patients are Not Well Managed On Topical Drops

If approved, bimatoprost sustained-release implant for glaucoma has potential to change the treatment paradigm

ALLERGAN
Our pursuit. Life's potential.

New and Emerging Surgical Technologies

- CORNEAL CROSS-LINKING (CXL)
- KERATOPROSTHESIS
- DROPLESS CATARACT SURGERY
- MICROPULSE LASER TRABECULOPLASTY (MT)
- TRABECULOTOME
- STENTS, SHUNTS, TUBES
- JETREA
- RETINAL IMPLANTS

Keratoprosthesis

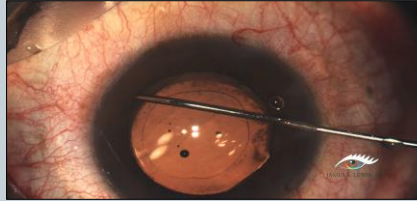
- × Treatment option for severe corneal opacification when PK repeatedly fails or is not possible
- × Donor graft + prosthesis
- × Multicenter study (2006):
 - × 57%: BCVA ≥20/200 at 8.5mos
 - × Post-op complications:
 - × Retroprosthetic membrane (RPM): 25%
 - × Ocular hypertension: 15%
 - × Vitritis: 5%
- × Boston KPro Type 2:
 - × Complete tarsorrhaphy performed

Zerbe BL, Belin MW, Ciolino JB. Results from the multicenter Boston Type 1 Keratoprosthesis Study. Ophthalmology 2006;113(10):1779.

-Droless Cataract Surgery

- ✗ **Intravitreal transzonular antibiotic/steroid injection concurrent with cataract surgery**
 - ✗ Trimoxi (triamcinolone/moxifloxacin, Imprimis Pharmac.)
 - ✗ Injected through incision underneath iris/through zonules/into anterior vitreous after IOL in place, just prior to removing viscoelastic
- ✗ **Initial recovery VA is poor (due to milkiness of triamcinolone); ~50% BCVA is 20/100 or worse 1day post-op**
 - ✗ By 3wks, BCVA 20/40 or better in 96% of eyes
- ✗ **CME rates: 2-2.5% ("typical" phaco CE: 14%)**

Droless Cataract Surgery

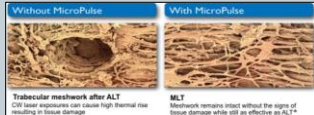


Micropulse Laser Trabeculoplasty

- ✗ **Argon Laser Trabeculoplasty (ALT) (1979)**
 - ✗ High power argon laser, small spot size
- ✗ **Selective Laser Trabeculoplasty (SLT) (1998)**
 - ✗ Lower power (Nd:YAG) laser, larger spot size
- ✗ **Micropulse Laser Trabeculoplasty (MLT) (2005)**
 - ✗ -chopping laser in sequence of ON and OFF intervals
 - ✗ Limits thermal spread to adjacent tissue
 - ✗ Treatment risks reduced, patient comfort increased

Micropulse Laser Trabeculoplasty

- ✗ **Micropulse Laser in DME Tx:**
 - ✗ Decreased photothermal effects; outcomes equal to or better than continuous wave (CW) focal laser Tx
- ✗ **MLT is effective without signs of thermal damage seen in ALT**

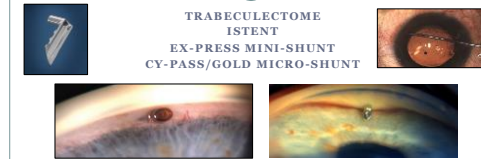


MLT vs. SLT?

- ✗ **MLT: thermally affects—but does not destroy—pigmented TM, without thermal/collateral damage**
- ✗ **MLT: more titratable than SLT**
 - ✗ Pulse energy control
 - ✗ ON/OFF times; frequency of repetition
- ✗ **Use of micropulse laser for other indications**
 - ✗ Diabetic macular edema
 - ✗ Suture lysis
- ✗ **potentially lower postoperative inflammation and IOP spikes than SLT**
- ✗ **Study forthcoming...**



MIGS Microinvasive Glaucoma Surgery



MIGS

- ✗ Less disruptive to tissue than traditional glaucoma surgeries (e.g. trabeculectomy)
- ✗ Shorter surgery and healing time
- ✗ Higher safety profile
 - ✗ no long-term safety or effectiveness data
- ✗ **-ab-interno** (inside the eye):
 - ✗ iStent
 - ✗ Trabeculectome
- ✗ **-ab-externo** (outside the eye):
 - ✗ Ex-PRESS mini-shunt

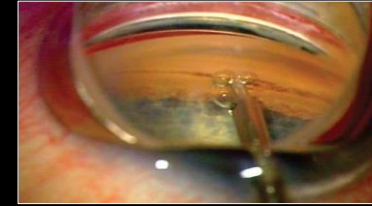
Trabeculectome

- ✗ Electrosurgical handpiece used to remove strip of TM and inner wall of Schlemm's canal
- ✗ Minimally invasive
- ✗ Can be done in conj. with cataract extraction
- ✗ Study (2006), 101 patients
 - ✗ Mean IOP: 27.7
 - ✗ Mean IOP 30 months post-op: 16.3 (mean IOP: 40%)
- ✗ Better safety profile than trabeculectomy

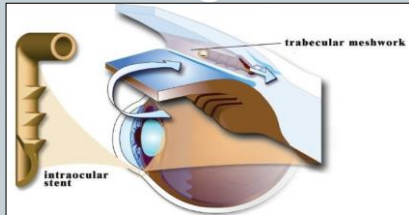


Minckler D, Baerveldt G, Ramirez MA et al. Clinical results with the trabeculectome, a novel surgical device for treatment of open-angle glaucoma. Trans Am Ophthalmol Soc 2006; 104:40-50.

Trabeculectome

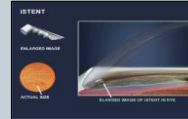


iStent



iStent

- ✗ Trabecular –micro-bypass!
- ✗ 1-mm long stent inserted into end of Schlemm's canala using injection tool through



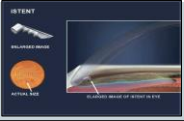
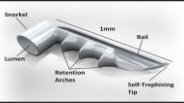
iStent

- ✗ **Contraindications**
 - ✗ Primary or Secondary Angle Closure GL (including neovascular glaucoma)
 - ✗ Diseases that may cause increased episcleral venous pressure, e.g.:
 - Retrobulbar tumor
 - Thyroid eye disease
 - Sturge-Weber Syndrome

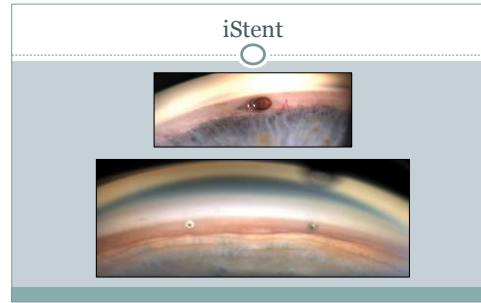


iStent

- ✗ Study on mild-to-moderate POAG patients, combined with cataract extraction:
 - ✗ 64% had sustained 20% IOP (vs. 47% with cataract extraction alone)
 - ✗ patients who had CE alone were 2x more likely to require GL medication than iStent group

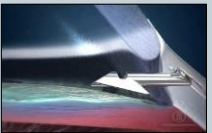
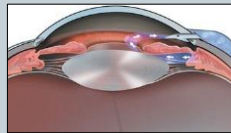



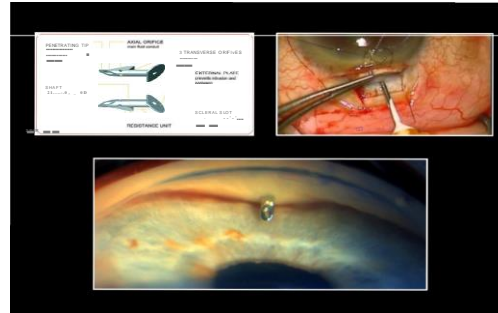
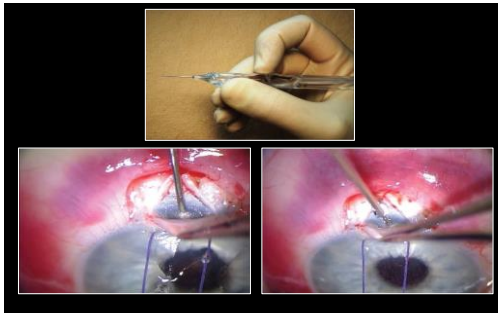
Samelson TW, Katz LJ, Wells JM, Duh Y, Giampetroso JE. Randomized evaluation of the trabecular micro-bypass stent with phacoemulsification in patients with glaucoma and cataract. Ophthalmology. 2011; 118(3):499-507.



Ex-PRESS Mini-shunt

- ✗ Designed to augment conventional trabeculectomy
 - ✗ Minimally Invasive??

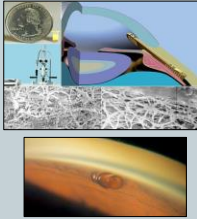


Ex-PRESS Mini-shunt

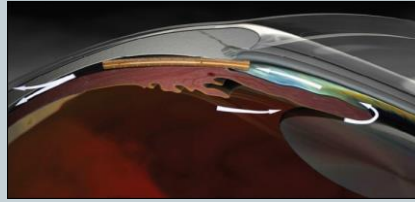
- ✗ Standard Trabeculectomy vs. Ex-PRESS mini-shunt under partial-thickness scleral flap
 - ✗ Retrospective study of 100 eyes
 - ✗ 50 trab+Ex-PRESS mini-shunt
 - ✗ 50 controls
 - ✗ No long-term statistical differences in mean IOP or number of glaucoma medications needed
 - ✗ Fewer post-operative complications in Ex-PRESS mini-shunt group (hypotony, choroidal effusion)
- ✗ Conclusion: Ex-PRESS mini-shunt is as efficacious as traditional trabeculectomy, with less complications

CyPass/Gold micro-shunt

- × 99.95% pure gold Micro-stent delivered with a delivery tool into TM (during cataract extraction)
- × Aqueous drains through shunt into suprachoroidal space
- × (mimics uveoscleral outflow)



CyPass/Gold micro-shunt



The JAMA Network

From: Efficacy and Safety of Gold Micro Shunt Implantation to the Suprachoroidal Space in Patients With Glaucoma: A Pilot Study
Arch Ophthalmol. 2009;127(3):264-269. doi:10.1001/archophthalmol.2008.611

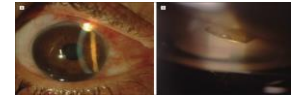


Figure Legend
Postoperative clinical image of a patient after GoldMicro Shunt implantation. Note the good position of the shunt in the anterior chamber (A), with no shunt contact or shunt-intra touching, as seen in the gonioscopic view (B).

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The JAMA Network

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Arch Ophthalmol. 2009;127(3):264-269. doi:10.1001/archophthalmol.2008.611

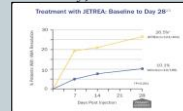
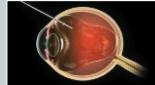


Figure Legend
Anterior segment optical coherence tomography showing the Gold Micro Shunt (GMS) in the suprachoroidal space. Note the spongiform appearance of the sclera, suggesting aqueous humor flow.

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Jetrea® (ocriplasmin)

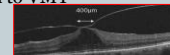
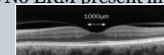
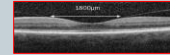
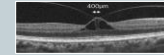
- × Proteolytic enzyme for vitreomacular traction Tx
- × First and only FDA-approved nonsurgical Tx
- × VMT resolution in 28 days
 - × 26.5% of patients (vs. 10.1% with vehicle only)
 - × 70% resolved by day 7

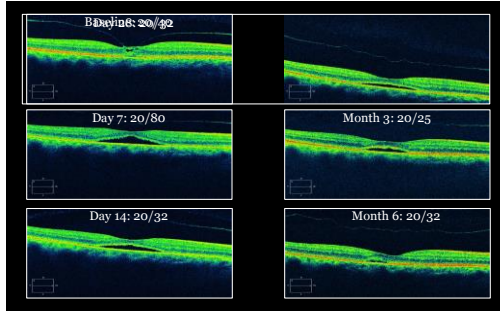


Stalmans P, Benz MS, Gandorfer A, et al. Enzymatic vitreolysis with ocriplasmin for vitreomacular traction and macular holes. *N Engl J Med.* 2012;367(7):606-615.

Jetrea® (ocriplasmin): Indications

- × Focal adhesion (<1500 μm) vs. broad
- × No ERM present in addition to VMT





Retinal Implants (–bionic eyes)

- ✗ Argus II (*Second Sight Medical Products*)
 - ✗ Video camera
 - ✗ Transmitter mounted to eyeglasses
 - ✗ Video processing unit (VPU)
 - ✗ Retinal prosthesis (electrode array)
- ✗ Tx of adults with severe to profound RP
- ✗ 2/14/2013: FDA-approved as Humanitarian Use Device
- ✗ Proven to improve spatial-motor visual performance
- ✗ Cost: ~\$100,000

Ho AC, Humayun MS, Dorn JD et al. Long-term results from an epiretinal prosthesis to restore sight to the blind. *Ophthalmology* 2015; 122(8):1547-54.

Retinal Implants (–bionic eyes)

- ✗ Intelligent Retinal Implant System (*IRIS*)
 - ✗ Intraretinal implant
- ✗ Retina Implant AG
 - ✗ Subretinal implant

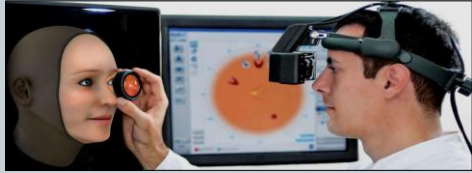
Chuang AT, Margo CE, Greenberg PB. Retinal implants: a systematic review. *Br J Ophthalmol* 2014; 98(7):852-6.

The Eye Exam of the Future

Virtual & Augmented Reality

Augmented Reality in Optometric Education

Augmented Reality in Optometric Education



Other options for Augmented Reality

- **TrueVision® Systems**
 - Surgical 3D visualization and guidance software
- **LaForge Optical**
 - Prescription eyewear that displays notifications from you smartphone
- **Innovega**
 - iOptik™ lenses
 - HD/3D video eyewear
 - Consumer
 - Defense and Covert Operations
 - Low Vision

A Vision for EVERYONE

Design

Prototype - Test - Refine

http://prezi.com/whwto97lg5m/?utm_campaign=share&utm_medium=copy&rc=ex0share



- “*Medicine begins where the technology ends.*”
Edmund Pellegrino, M.D. The Father of Modern Biomedical Ethics

- “*Medicine is a moral enterprise, and if you take away the ethical and moral dimensions, you end up with a technique. The reason it is a profession is that it's dedicated to something other than its own self-interests.*” Edmund Pellegrino, M.D. Georgetown Magazine, 1996.

Questions?



Thomas A. Wong, OD (tawong@sunyopt.edu)
Matthew D. Bovenzi, OD, FAAO (mbovenzi@sunyopt.edu)