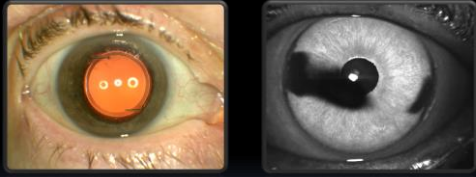


## Anterior Segment Imaging With Retinal Cameras



Timothy J. Bennett, CRA, OCT-C, FOPS  
Penn State Eye Center  
Hershey, PA



## The Case of the Century!

- Doctor: Can you photograph this amazing fascioma of the cornea? It's never been reported before and we want to publish it!
- Photographer: The cornea? But we don't have a photo slit-lamp.
- Doctor: What are we paying you for? Why don't you just improvise?



## The Case of the Century!

- Doctor: Can you photograph this amazing fascioma of the cornea? It's never been reported before and we want to publish it!
- Photographer: The cornea? But we don't have a photo slit-lamp.
- Doctor: What are we paying you for? Why don't you just improvise?



## Why Not Improvise?



phrases, sayings, idioms and expressions at

### The Phrase Finder

The meaning and origin of the expression: **Necessity is the mother of invention**

Home > Phrase Dictionary - Meanings and Origins > Necessity is the mother of invention

**Necessity is the mother of invention**

**Meaning**  
Difficult situations inspire ingenious solutions.

**Origin**  
The author of this proverbial saying isn't known. It is sometimes ascribed to Plato and it does appear in translations of Plato's *Republic*. Those translations weren't made until much later than the phrase was in common use in English and are more likely to be the work of the translator than being a literal version of Plato's words. The proverb was known in England by the 16th century, although at that point it must have been known to very few as it was then documented in its Latin form rather than in English. Many well-known proverbs appeared first in Latin and were transcribed into English by Erasmus and others, often as training texts for Latin scholars.

William Horner, the headmaster of Winchester and Eton, included the Latin form *"Necessitas mater inventio"* in *Vulgaris*, a book of apophthegms for the boys of the schools to learn by heart, which he published in 1519.

Roger Ascham came close to an English version of the phrase in his manual on how to use a longbow, which is by the way the first book ever written about archery, *Toxophilus*, 1545:

"Necessitas, the inventour of all goodnesse."

## Necessity is the Mother of Invention

Build a better mousetrap  
and the world will beat  
a path to your door.

- Ralph Waldo Emerson  
(1803 - 1882)



**BrainyQuote®**

Authors Topics Quote of the Day Pictures [Contact Us](#)

Authors: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

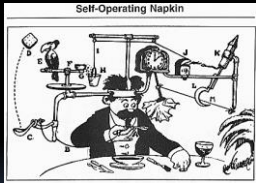
I have not failed. I've just found 10,000 ways that won't work.

Thomas A. Edison

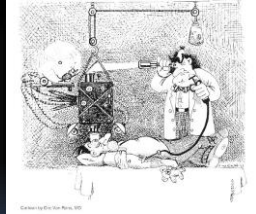
[More Quotes by Thomas A. Edison](#)



## Necessity is the Mother of Invention



Professor Butts' Self-Operating Napkin  
Rube Goldberg, ca. 1930

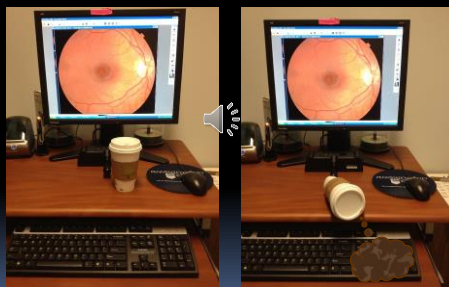


Fluorescein Angiography, Eric Van Rens, MD  
Journal of Ophthalmic Photography, Vol 13(1) 1993

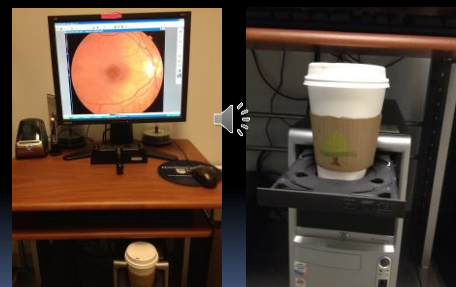
## Necessity is the Mother of Invention

- Instead of inventing something, why not use something you already have at your disposal?

## Why Not Improvise?



## Why Not Improvise?



## Why Not Improvise?



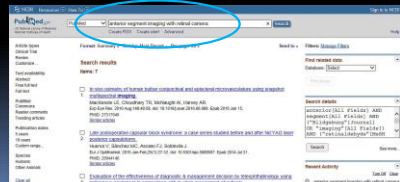
## Why Not Improvise?



Testing flash synchronization connection between instrument and camera.

## Why Don't You Just Improvise?

- What can you do if you don't have a slit-lamp?
  - Use your iPhone?
  - Maybe there's a better way.
  - Let's look at the literature.



## Literature Search

### Pigmented Iris Angiography

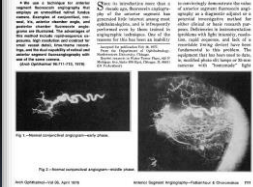
Thou J. Research. MBBS (Ophthalmology), MRCOphth (UK), FRCOphth (UK)



Arch Ophthalmol - Vol 94, 1976

### Anterior Segment Fluorescein Angiography With a Retinal Fundus Camera

Thou J. Research. MBBS (Ophthalmology), MRCOphth (UK), FRCOphth (UK)

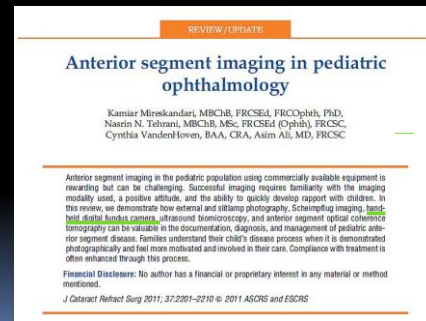


Arch Ophthalmol - Vol 96, 1978

## Literature Search



## Literature Search



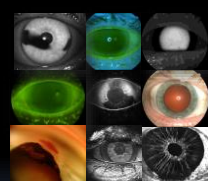
## Literature Search



Journal of Ophthalmic Photography, Vol 36:40-45, 2016

## AS Imaging with Retinal Cameras

- Fundus camera red reflex
- Monochromatic imaging
- RetCam gonio
- Iris/AS angiography
- Corneal staining
- SLO confocal shift
- Autofluorescence
- Meibography
- Pupillography



## Retinal Instruments

- Fundus Camera
  - Red reflex
  - Corneal Staining
  - Iris/AS angiography
  - Autofluorescence
- Handheld Fundus Camera
  - Goniophotography
- cSLO
  - Iris/AS angiography
  - Corneal Staining
  - Autofluorescence
  - Confocal focus-tonal shift
  - IR Meibography
  - IR Pupillography
  - Video recording

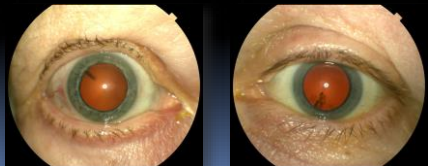
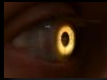
## Retinal Instruments

- Fundus Camera
  - Red reflex
  - Corneal Staining
  - Iris/AS angiography
  - Autofluorescence
- Handheld Fundus Camera
  - Gonio



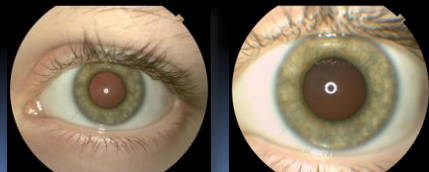
## Fundus Camera

- Axial illumination/red reflex
- Donut shaped cornea reflex
- Optics designed for concave curved subject
- Edge distortion & shallow depth of field



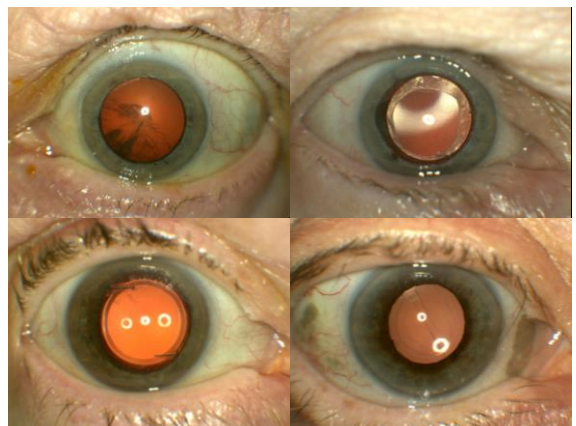
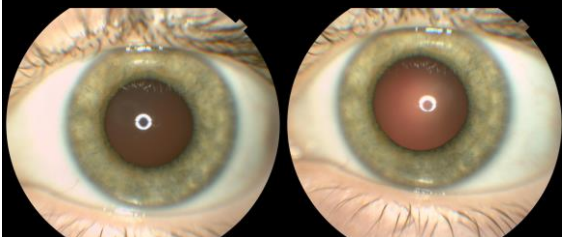
## Fundus Camera

- Plus diopter "+" or "A" setting
  - + setting: lower mag, but less distortion
- Set focus knob all the way forward
- Move joystick to focus



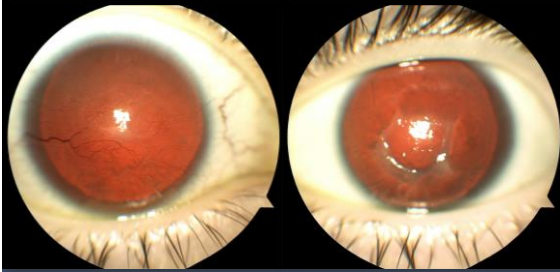
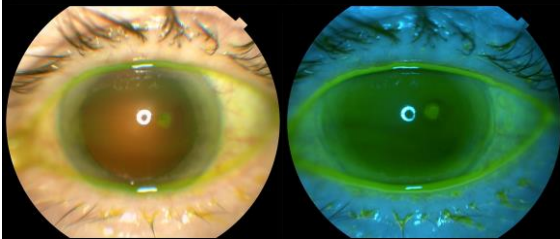
## Fundus Camera

- Align optic disc behind lens to increase brightness of retroillumination





## Fundus Camera

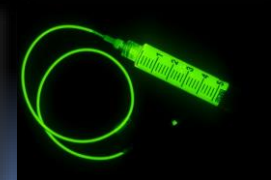
Fundus Camera:  
Topical Fluorescein Staining

## Exciter and Barrier Filters

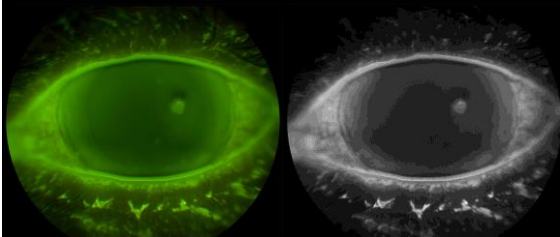
- Filters/wavelengths used for fluorescein angiography.
- Built-in to fundus cameras and SLOs.



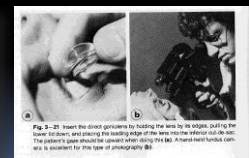
Blue (465-490 nm) excites fluorescence



Barrier (520-540 nm) transmits fluorescence only

Fundus Camera:  
Topical Fluorescein StainingHandheld Fundus Camera  
Goniophotography

- Koepple Lens
- Reclined/supine position
- Handheld fundus camera (axial illumination)

Wong, D. *Textbook of Ophthalmic Photography*, 1982

## RetCam Goniophotography

### ORIGINAL ARTICLE



Leslie MacKeen, BSc, CRA  
Clarify Medical Systems, Inc.  
Pleasanton, California, USA 94588  
647/309-9271  
925/463-7990 Fax  
lmackeen@clarifymsi.com

Cynthia Vandenhoven, BAA, CRA  
The Department of Ophthalmology and  
Vision Sciences  
The Hospital for Sick Children  
Toronto, Ontario, Canada M5G 1X8  
416/813-6521  
416/813-7040 Fax  
cynthia.vandenhoven@sickkids.ca

### Direct Goniophotography Using the RetCam

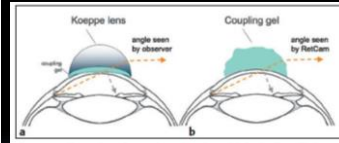
#### Abstract

Goniophotography is traditionally performed in a clinical setting using a table-top mounted photo slit lamp biomicroscope with gonio mirrors. Although commonly known as being a wide field fundus camera, by modifying the imaging technique, the RetCam can effectively



Journal of Ophthalmic Photography 33(2), 2011

## RetCam Goniophotography



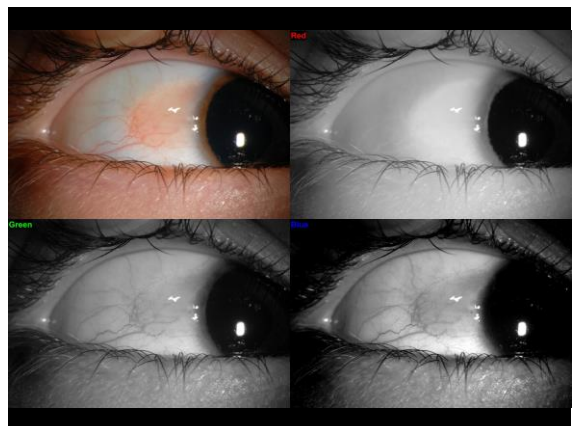
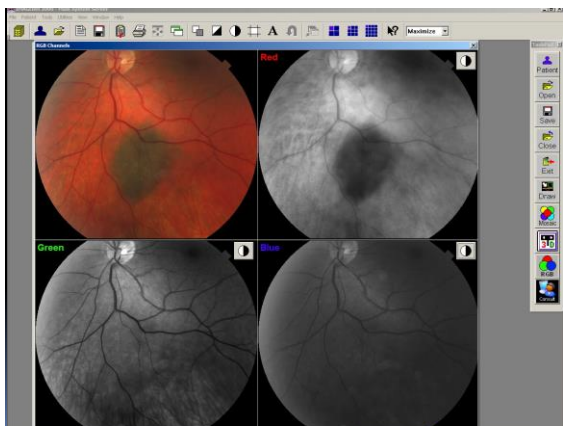
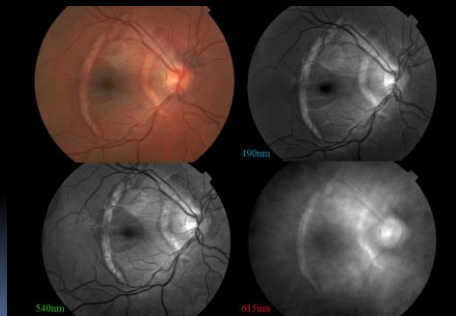
Journal of Ophthalmic Photography 33(2), 2011

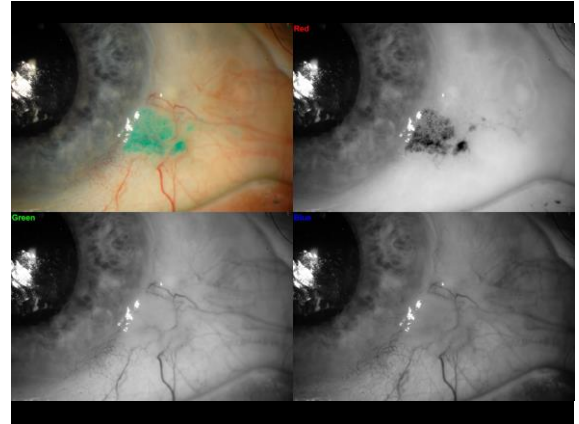
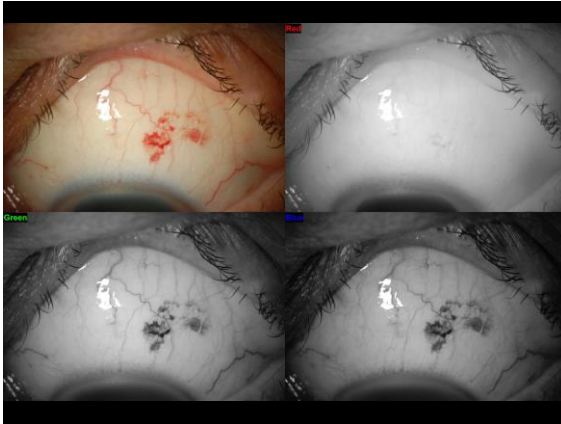


## RetCam Goniophotography



## Monochromatic Information





## Retinal Instruments

- cSLO
  - Monochromatic/grayscale imaging
    - IR 820nm
    - Blue reflectance 588nm
  - Corneal Staining
  - Iris/AS angiography
  - Autofluorescence
  - Confocal focus-tonal shift
  - IR Meibography
  - IR Pupillography
  - Video recording

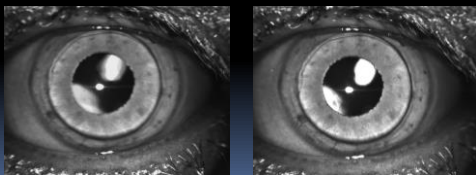
## cSLO - Spectralis HRA

- FA excitation and blue reflectance (red free)
  - 488nm solid state laser
- ICG excitation
  - 790nm diode laser
- IR Reflectance
  - 820nm diode laser



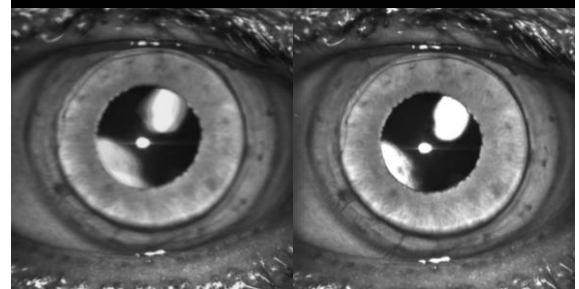
## cSLO - Spectralis HRA

- Normal lens or AS OCT objective
- Set focus to +30D
- Turn ART off (sampling degrades image)



IR Reflectance 820nm

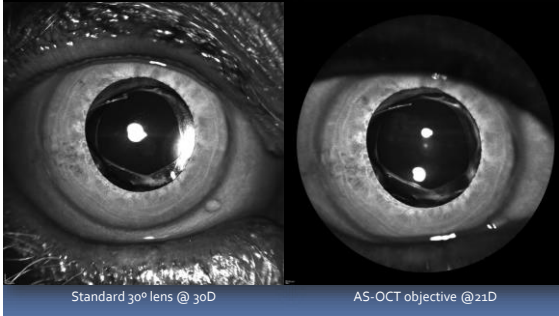
## cSLO - Spectralis HRA



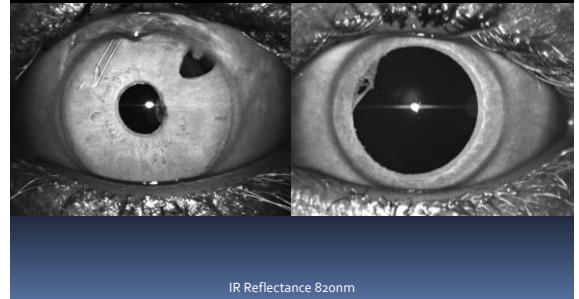
ART on, 9 frames averaged

ART off

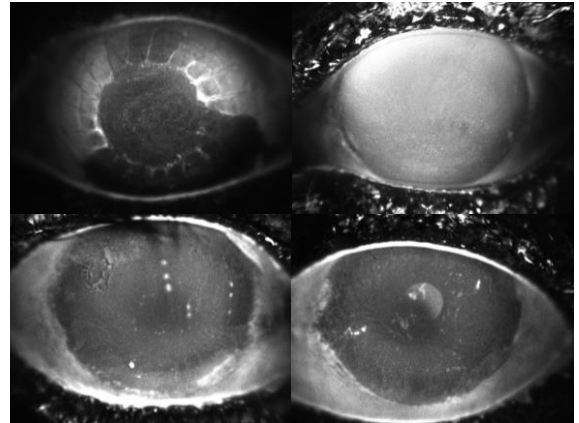
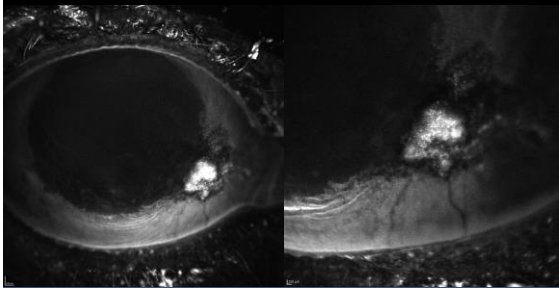
## Spectralis



## cSLO - Spectralis HRA



## Topical Fluorescein Staining



## Iris/AS Angiography



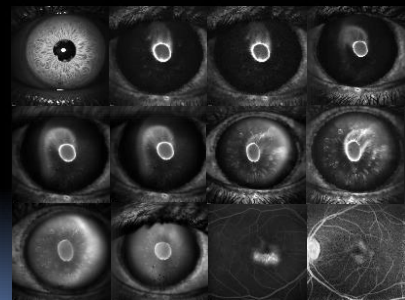
Wong, D. Textbook of Ophthalmic Photography, 1982



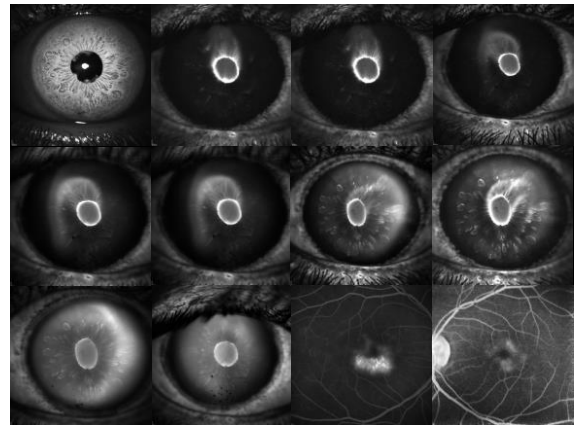
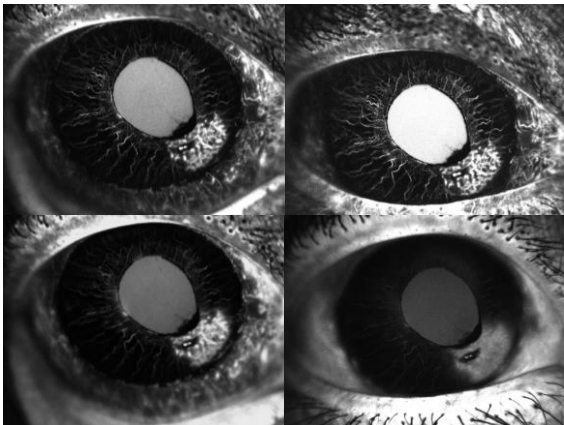
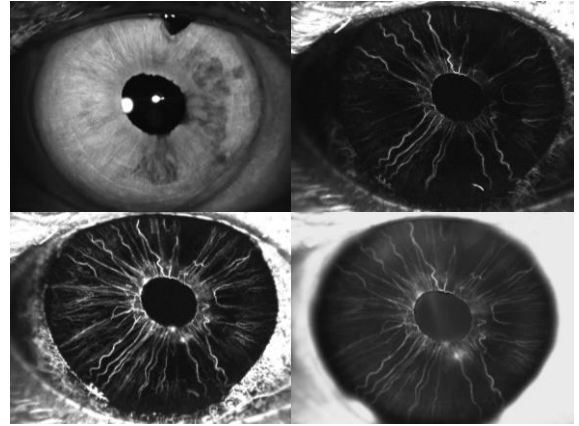
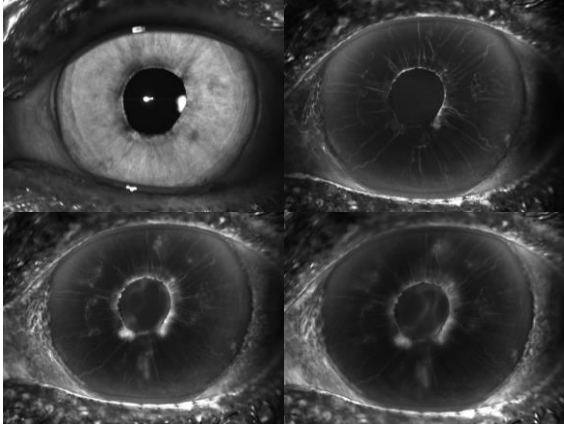
Bergstrom TS, et al. Arch Ophthalmol, 1996

Demeter U, et al. Journal of Ophthalmic Photography, 1986

## cSLO Iris Angiography

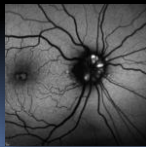






## Autofluorescence

- The term "autofluorescence" is used to distinguish fluorescence that can occur naturally vs. fluorescence from dyes.
- Optic nerve drusen, astrocytic hamartomas, and lipofuscin in the RPE can exhibit natural fluorescence.



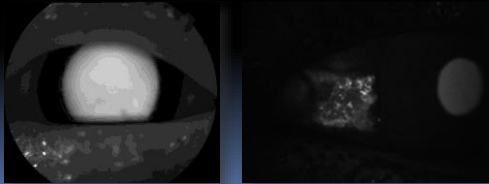
## Fundus Autofluorescence

- Fundus autofluorescence images can be captured with either a cSLO or modified fundus camera.



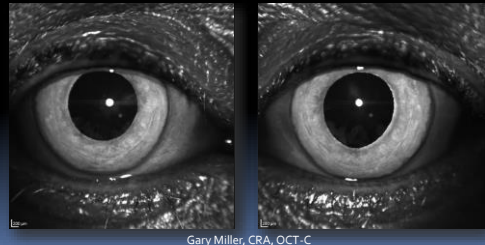
## Anterior Segment AF?

- Do any anterior segment structures exhibit autofluorescence?
  - Aging crystalline lens (cataracts)
  - Pingueculae



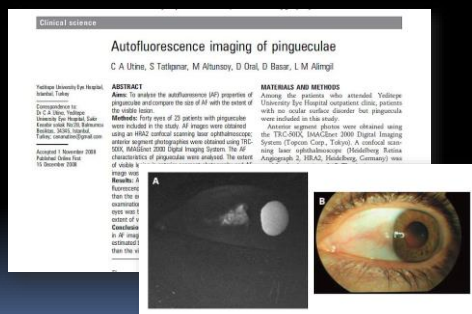
## Anterior Segment AF

- Inspiration from previous versions of this presentation.



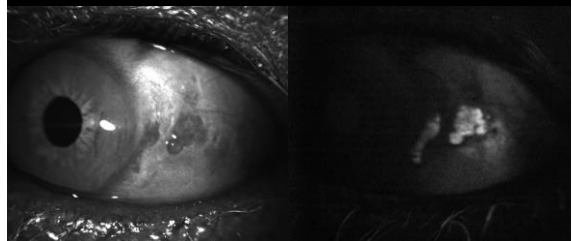
Gary Miller, CRA, OCT-C

## Autofluorescence



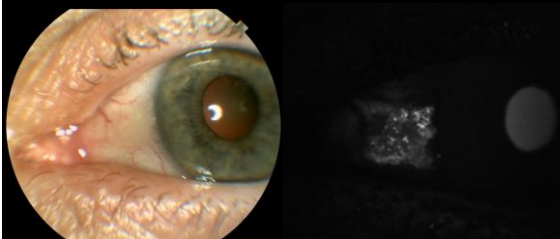
Br J Ophthalmol 2009;93:396-399.

## AF of Pinguecula



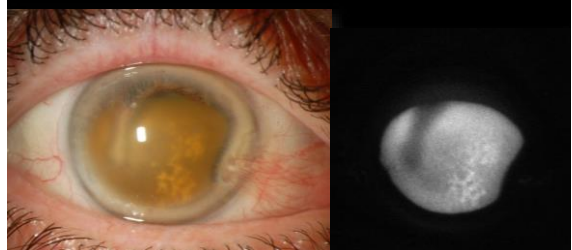
Spectralis cSLO AF 488/530 nm

## AF of Pinguecula



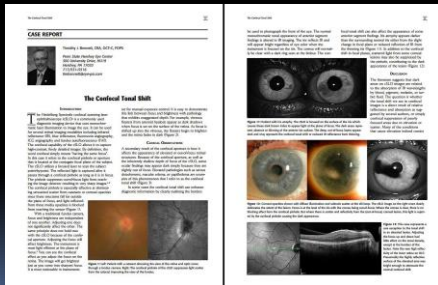
Modified Fundus Camera AF 560/660 nm

## AF of Hemosiderin/Hemoglobin



Spectralis cSLO AF 488/530 nm

## cSLO Confocal Tonal Shift



Journal of Ophthalmic Photography 33:17-22, 2016

## Confocal Imaging

con·fo·cal

/kən ˈfɒkəl/

adjective

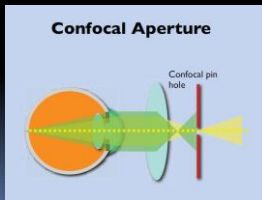
having a common focus or foci.  
"confocal ellipses"

• denoting or using a microscope whose imaging system only collects light from a small spot on the specimen, giving greater resolution.



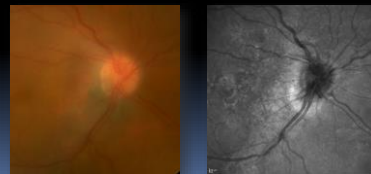
## cSLO Confocal Imaging

- Focused "coherent" laser light source.
- Confocal pinhole/aperture in front of image detector.



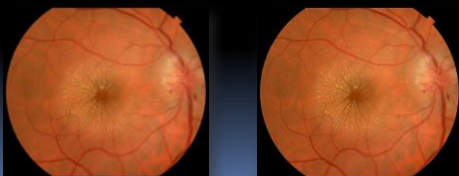
## cSLO Confocal Imaging

- A confocal aperture positioned at the focal plane blocks out-of-focus light from reaching the sensor to minimize scatter and improve contrast.



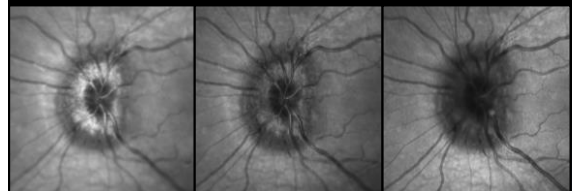
## Focus and Brightness

- With a traditional fundus camera, focus and brightness are independent of one another.
- Adjusting one does not significantly affect the other.



## cSLO Confocal Tonal Shift

- cSLO images are brightest at the plane of focus because of the confocal aperture.

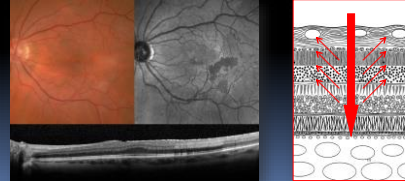


## cSLO Confocal Tonal Shift



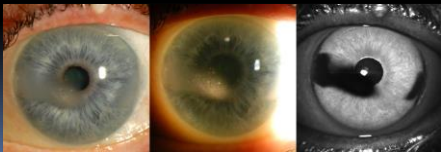
## Scattered Reflection

- Disruption of normally transparent tissue may appear dark. Scattered reflection will be slightly blurred and blocked by the confocal pinhole.



## cSLO Confocal Tonal Shift

- cSLO is focused on the iris with the cornea being slightly out-of-focus.
- The confocal pinhole suppresses scattered (out-of-focus) reflection from the cloudy areas of the cornea.



## cSLO Confocal Tonal Shift

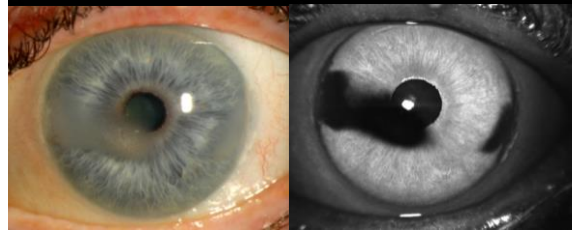
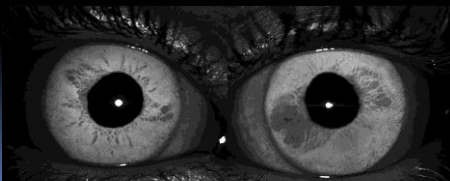


Photo slit lamp

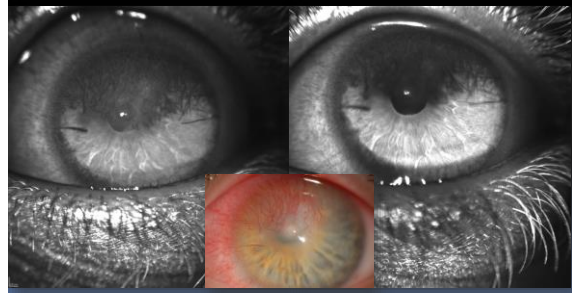
Spectralis cSLO IR 820 nm

## cSLO Confocal Tonal Shift

- Areas of iris atrophy/thinning appear dark.
- The deep out-of-focus areas may represent the confocal tonal shift or reduced IR reflectance from thinning.



## cSLO Confocal Tonal Shift





## IR Meibography



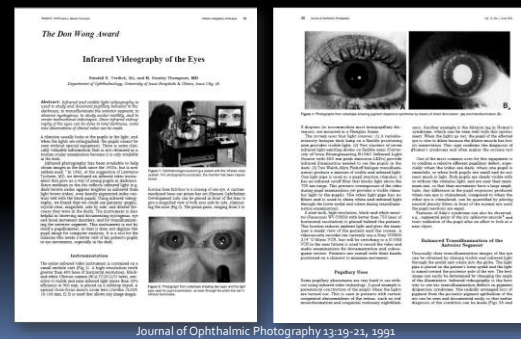
## IR Meibography



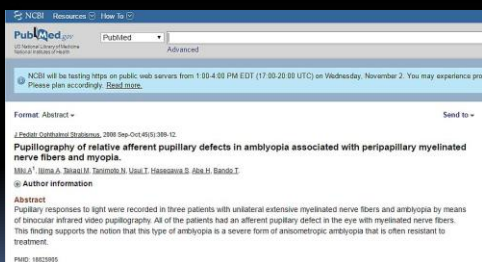
## IR Meibography



## IR Pupillography



## IR Pupillography

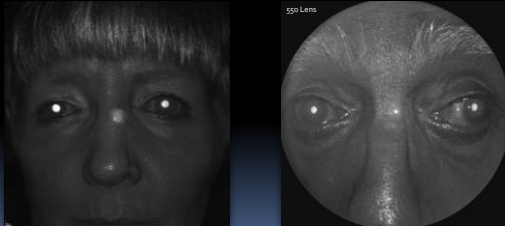


## IR Pupillography



## IR Pupillography

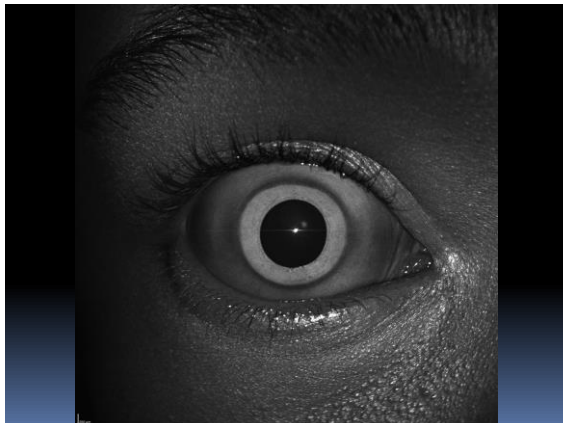
- Swinging flashlight test: APD



Erica DelValle, COT, OCT-C, Geisinger Medical Center

## IR Fundus Reflex

- IR iris transillumination or pupil imaging only works when focus of instrument is at the plane of the retina because of the confocal aperture.
- When focused at iris or pupil margin, the SLO is most light efficient at that level and there is no reflectivity from the fundus to transilluminate.
- In order to backlight iris, patient's head must be moved back from instrument.



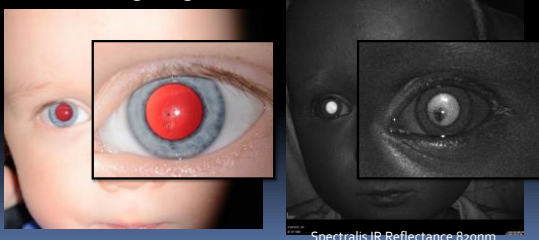
## IR Fundus Reflex

- 16 month old with congenital cataract



## IR Fundus Reflex

- 16 month old with congenital cataract
- Axial lighting



## Anterior Segment Imaging with Retinal Cameras

- Why Don't You Just Improvise?



## Be Like MacGyver:Improvise!

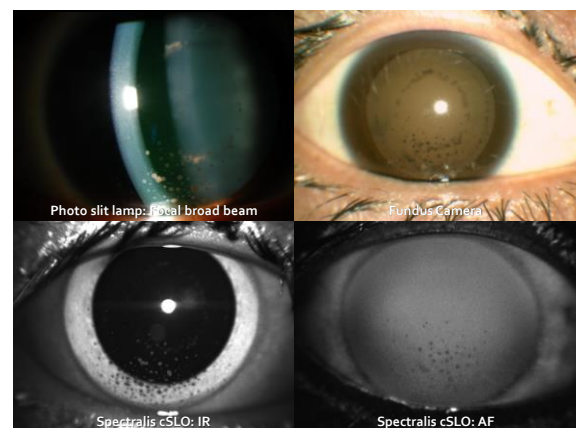
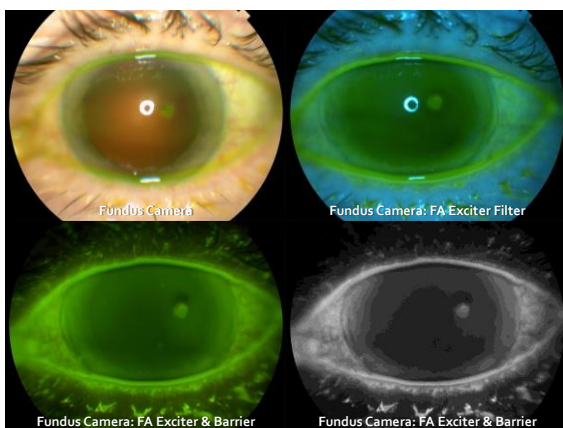
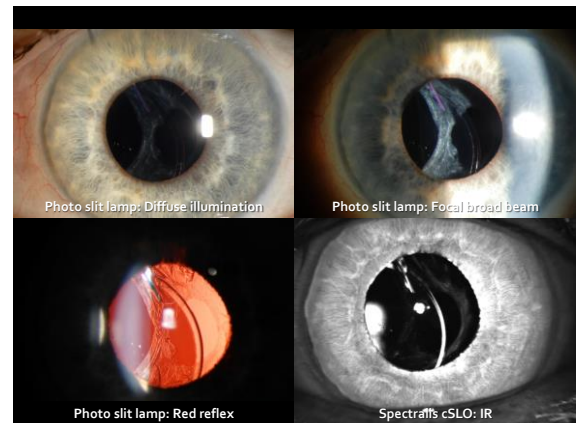
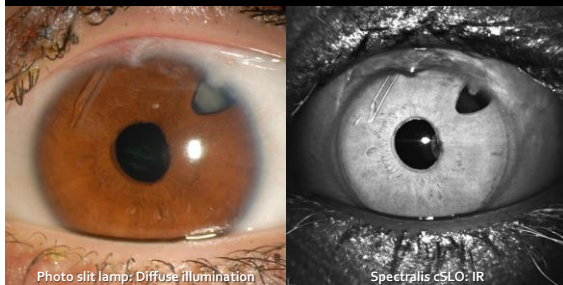
- Retinal devices provide several modalities that can also be adapted to use in anterior segment imaging.
- Some may be useful in place of, or as an adjunct to, photo slit lamp imaging.

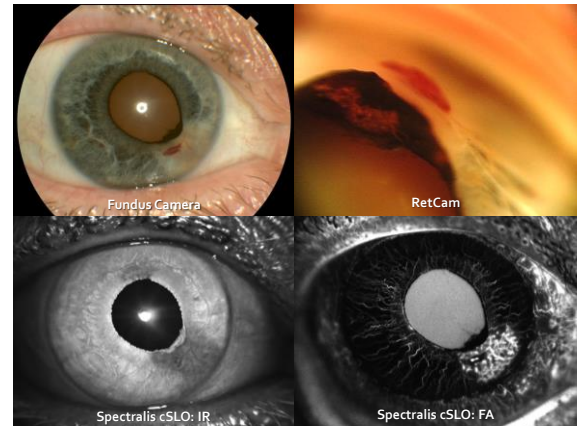


## Be Like MacGyver:Improvise!

- Fundus Camera
  - Red reflex
  - Corneal Staining
  - Iris/AS angiography
  - Autofluorescence
- Handheld Fundus Camera
  - Goniophotography
- cSLO
  - Iris/AS angiography
  - Corneal Staining
  - Autofluorescence
  - Confocal focus-tonal shift
  - IR Meibography
  - IR Pupillography
  - Video recording

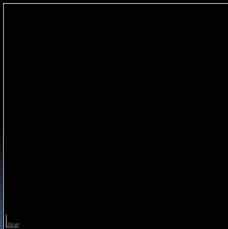
## Be Like MacGyver:Improvise!





## Be Like MacGyver:Improvise!

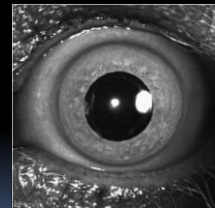
- AC free floating cyst



Jill Remaley OCT-C, Geisinger Medical Center

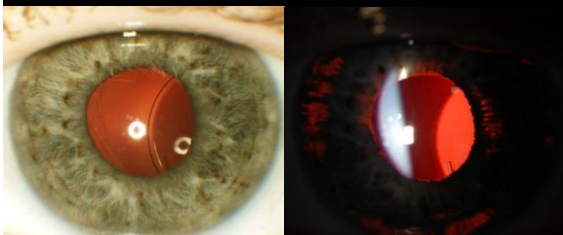
## Be Like MacGyver:Improvise!

- Torsional nystagmus



Gary Miller, CRA, OCT-C

## Sometimes the Right Tool...



## Be Like MacGyver:Improvise!

- Are there any MacGyvers in the audience?
- What other techniques or devices might work for AS imaging?



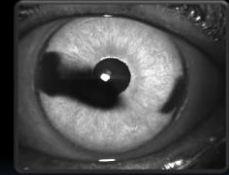


## Questions?

- Email: [timbennett@eye-pix.com](mailto:timbennett@eye-pix.com)
- Web: [www.eye-pix.com](http://www.eye-pix.com)



## Anterior Segment Imaging With Retinal Cameras



Timothy J. Bennett, CRA, OCT-C, FOPS  
Penn State Eye Center  
Hershey, PA

