

Early signs of diabetic eye disease

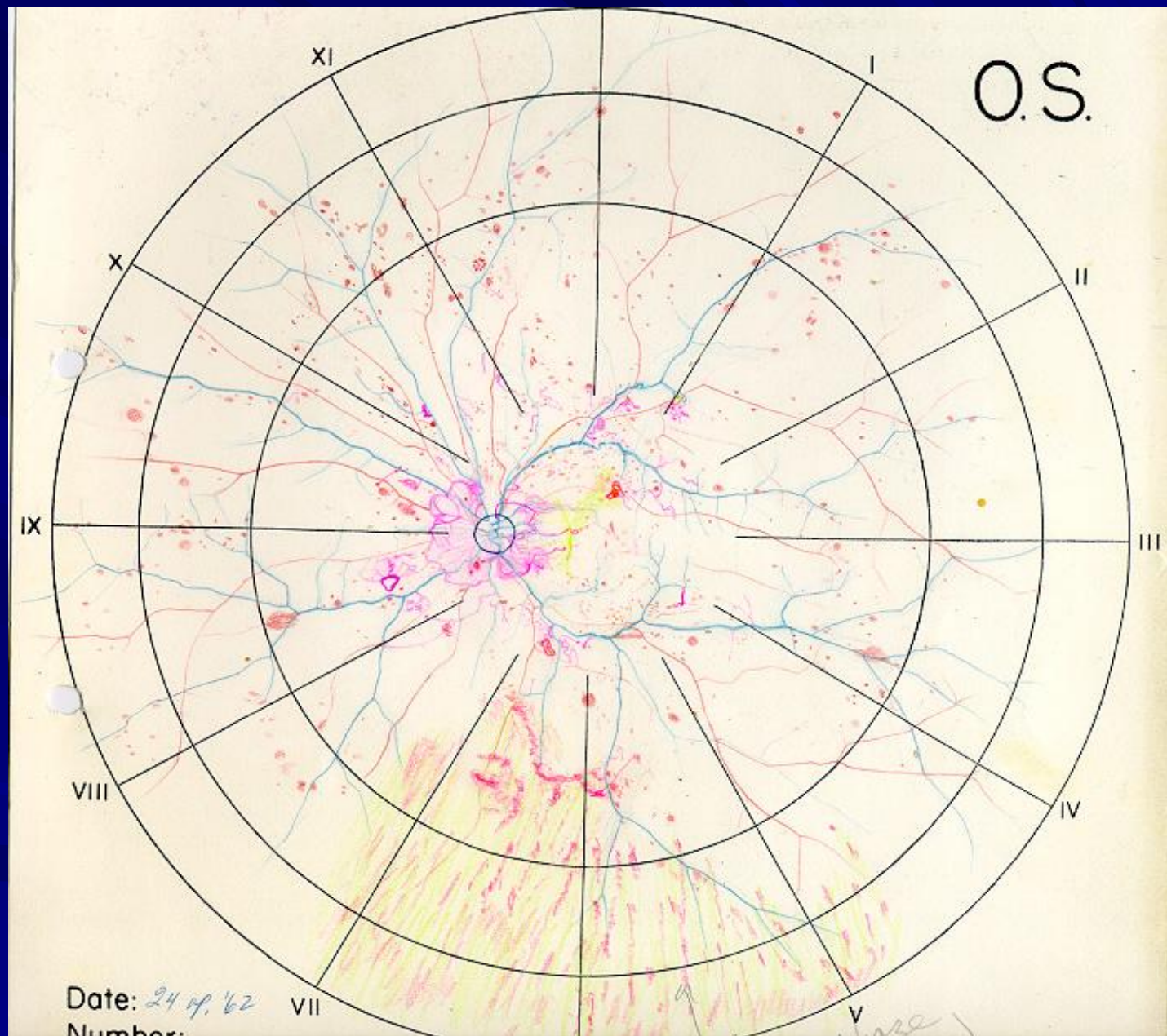
Professor Tunde Peto

Professor of Clinical Ophthalmology

Queen's University Belfast

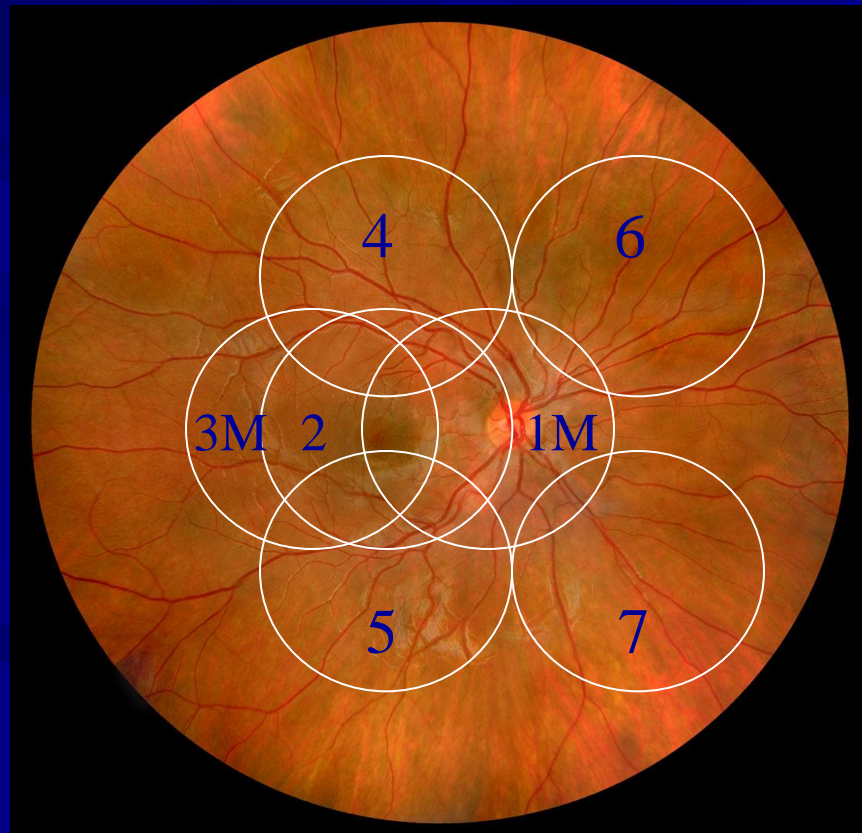


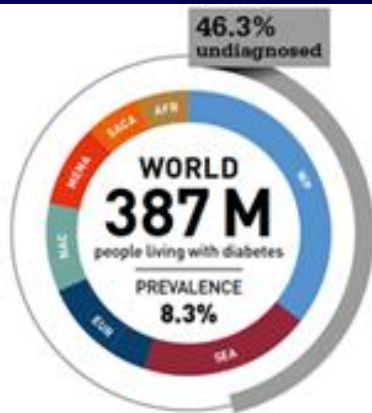
Retinal drawing circa 1962



Historical Perspective

The Modified Airlie House fields are further modified to their current configuration in the early 1990s to better capture DME





i/12
people with
DIABETES



4.9 million deaths in 2014

$\frac{3}{4}$ live in low and middle income countries

Diabetes: Complications

Macrovascular

Stroke

Heart disease and
hypertension

Peripheral
vascular disease

Foot problems

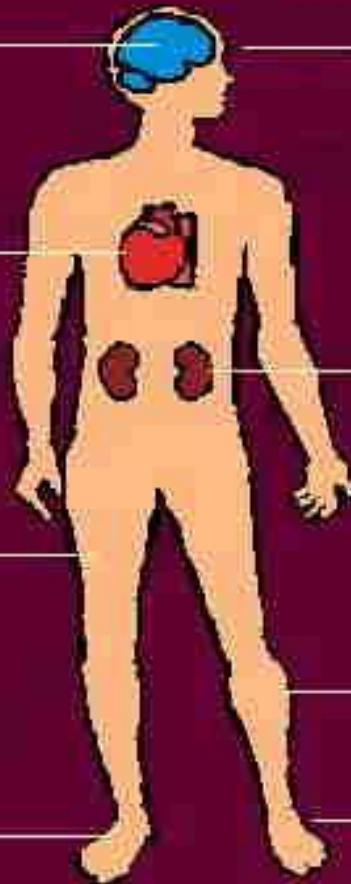
Microvascular

Diabetic eye disease
(retinopathy and cataracts)

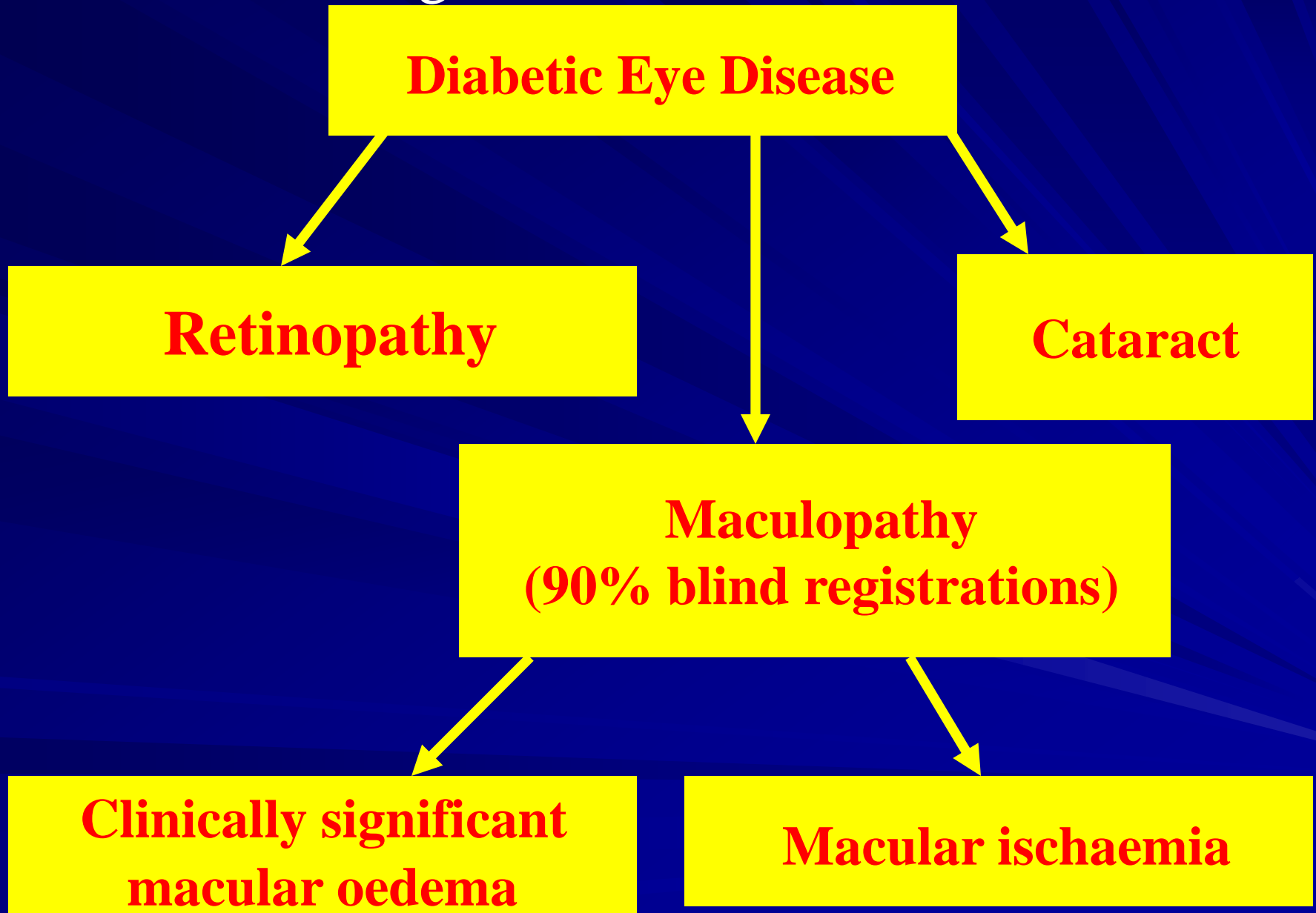
Renal disease

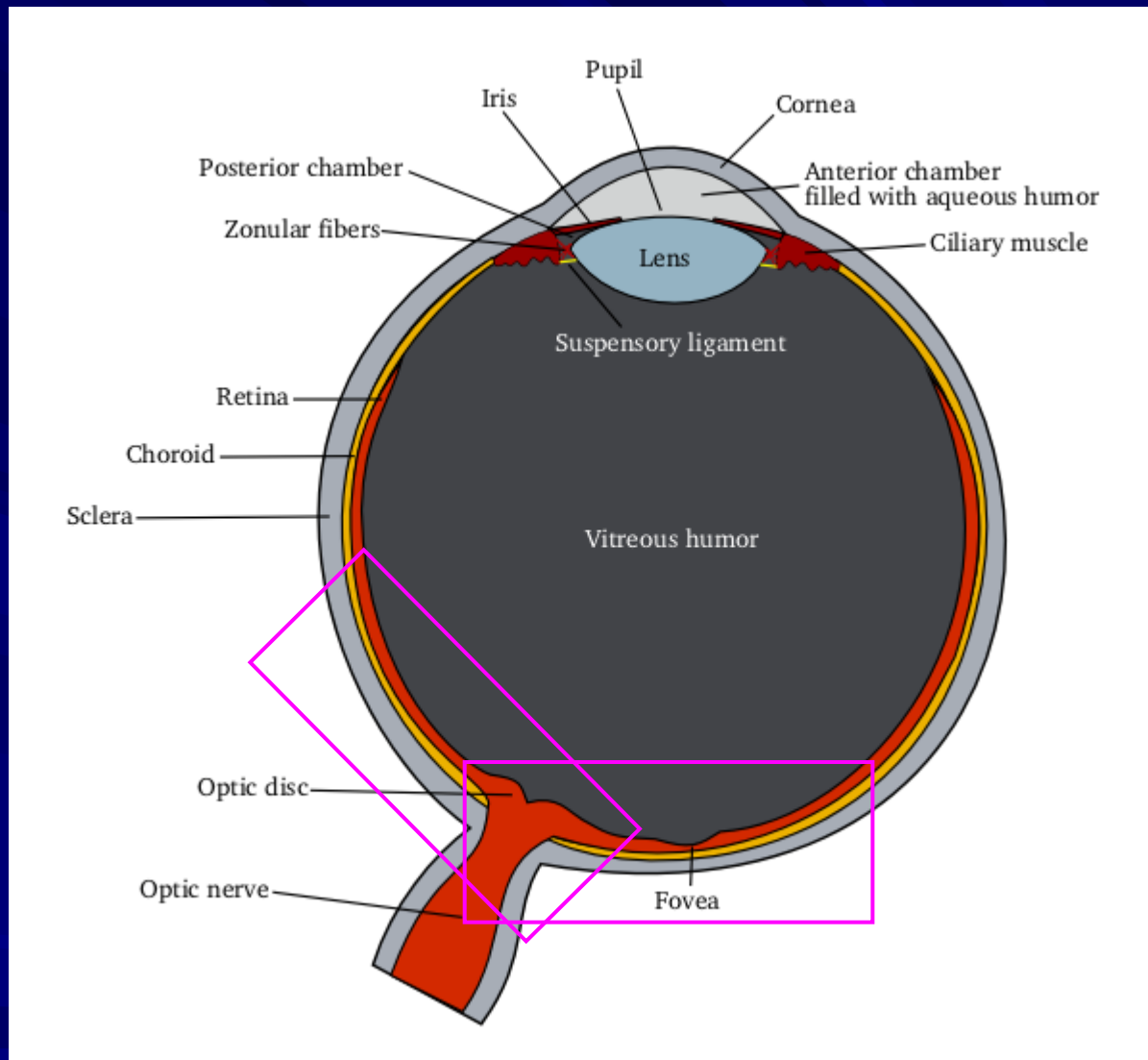
Neuropathy

Foot problems



Management: the burden of illness



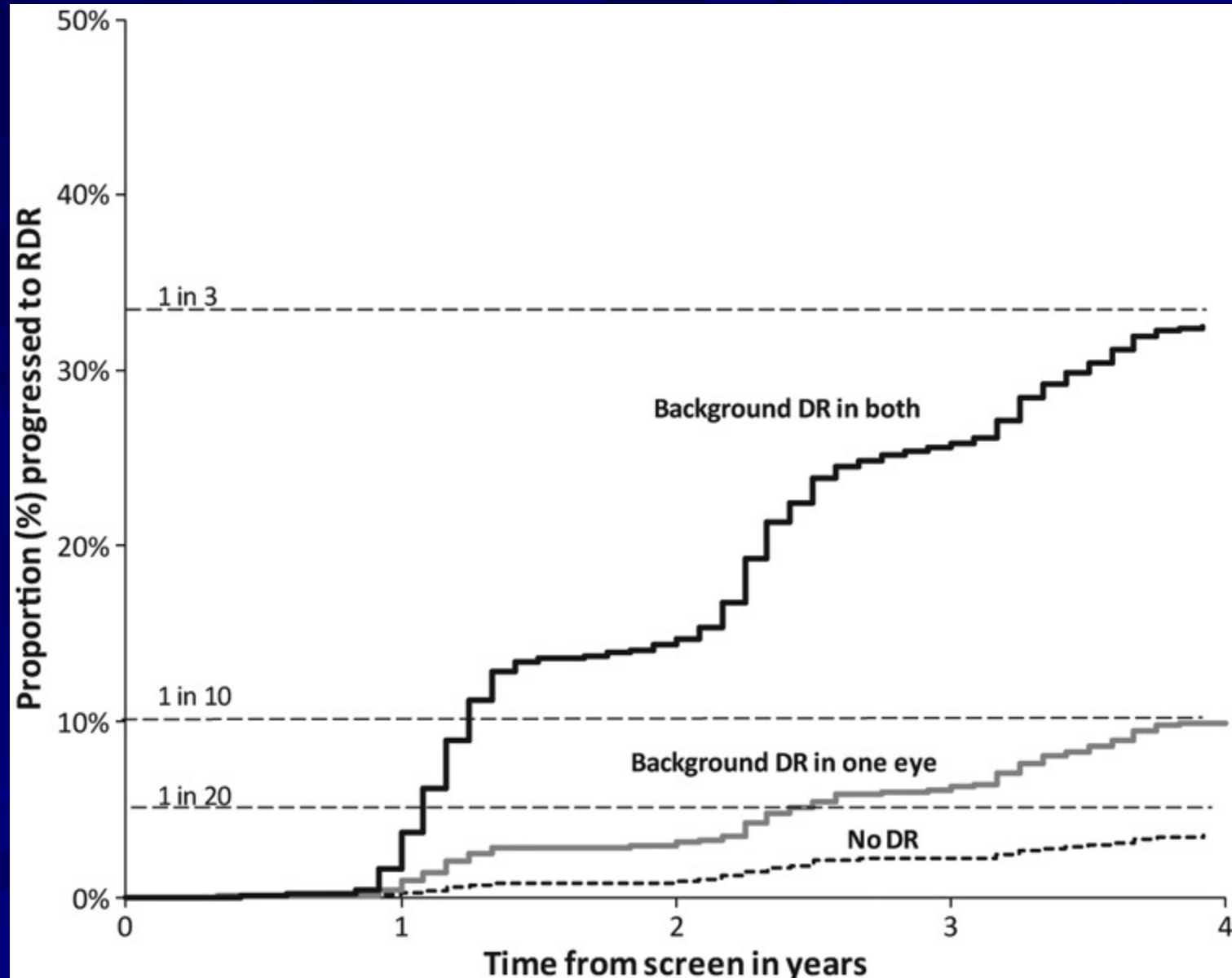


The areas of the two screening images per eye

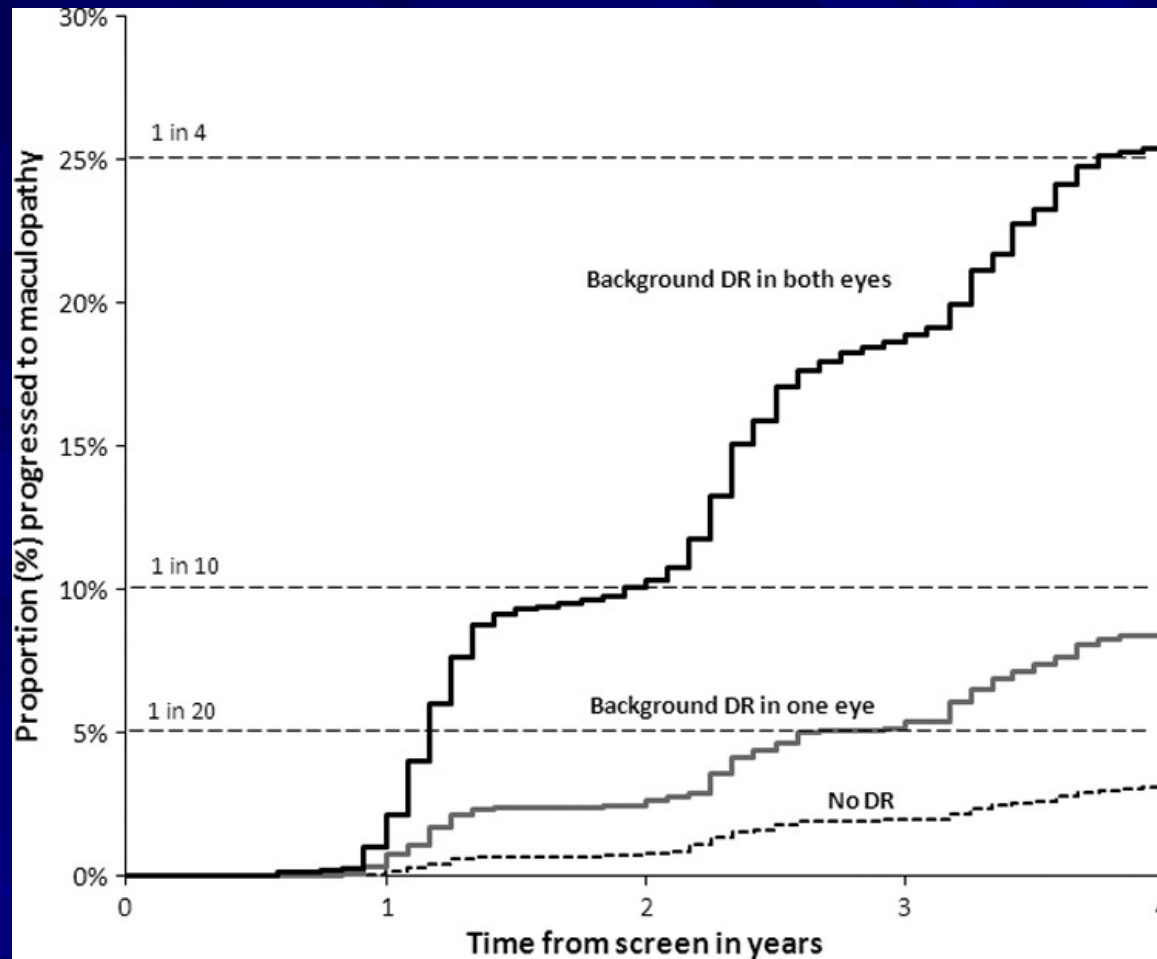
This is what the screener sees:



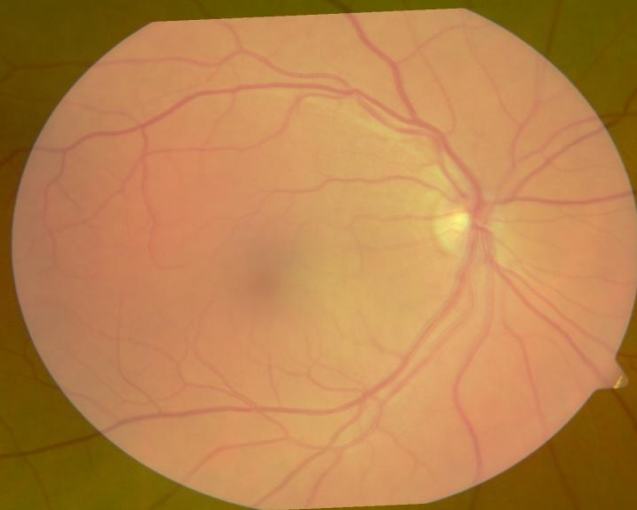
Progression to proliferative disease



Progression to maculopathy



Area covered by two field imaging field versus widefield imaging



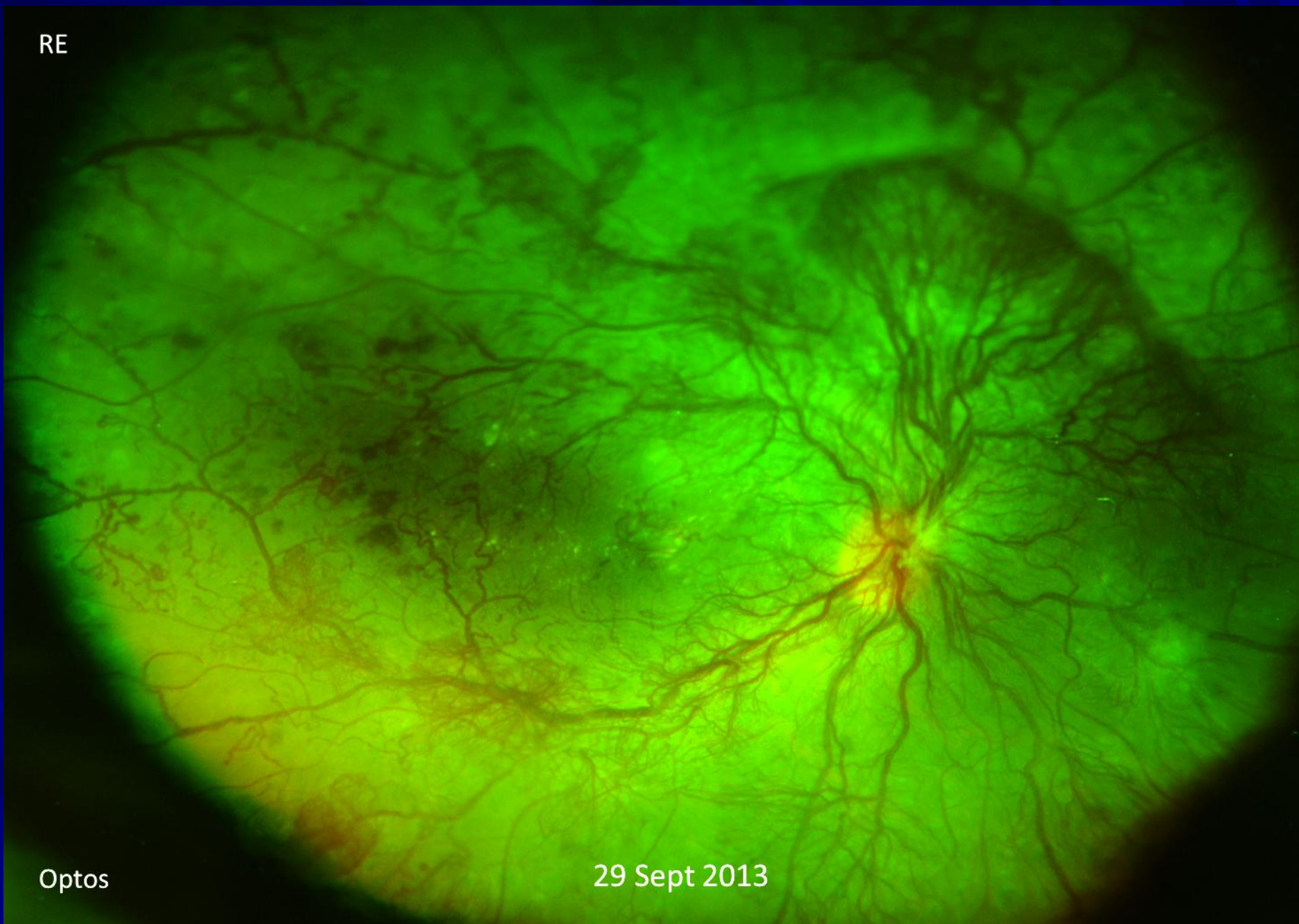
Peripheral Hemorrhages



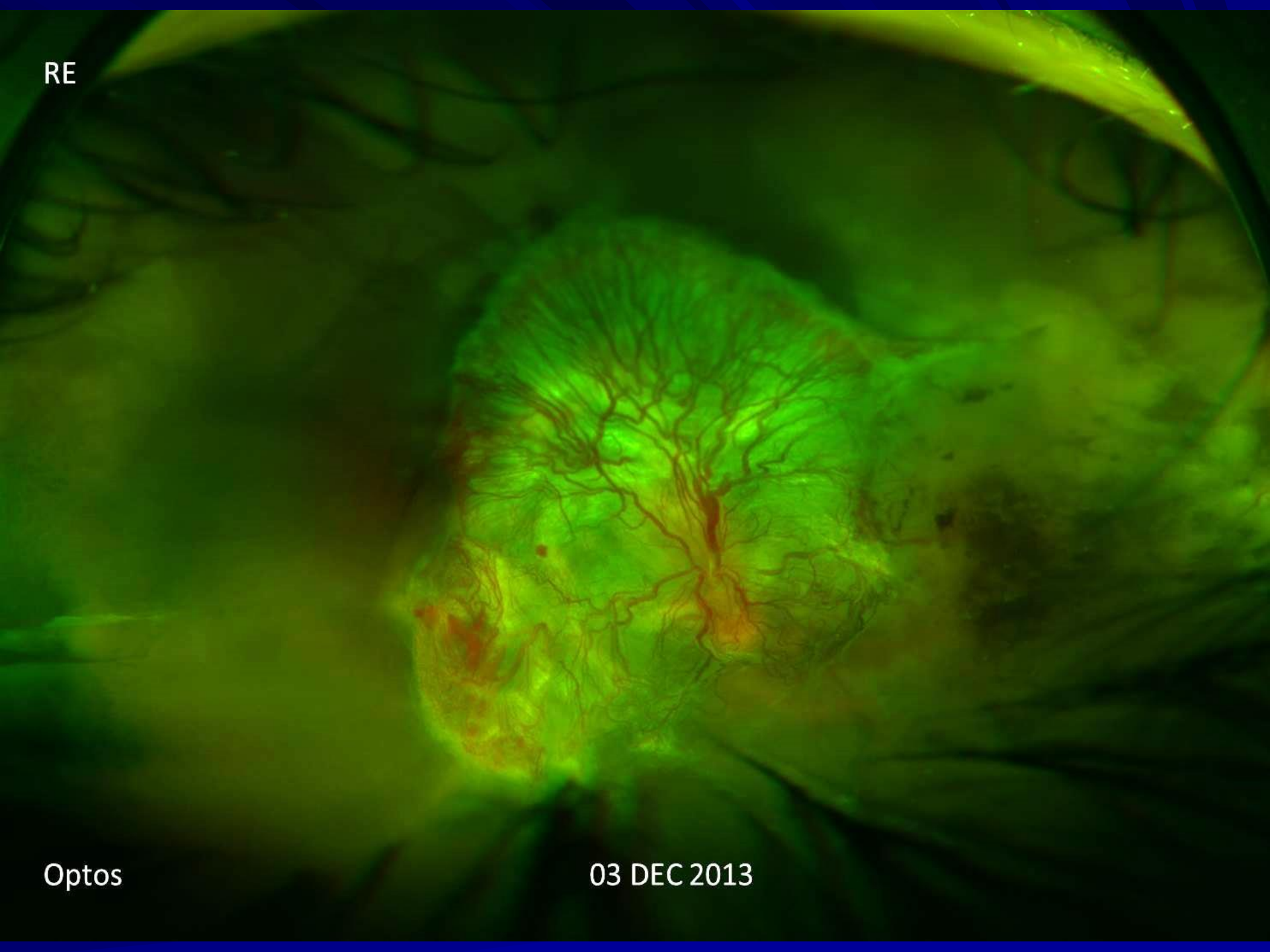
RE

Optos

29 Sept 2013



RE



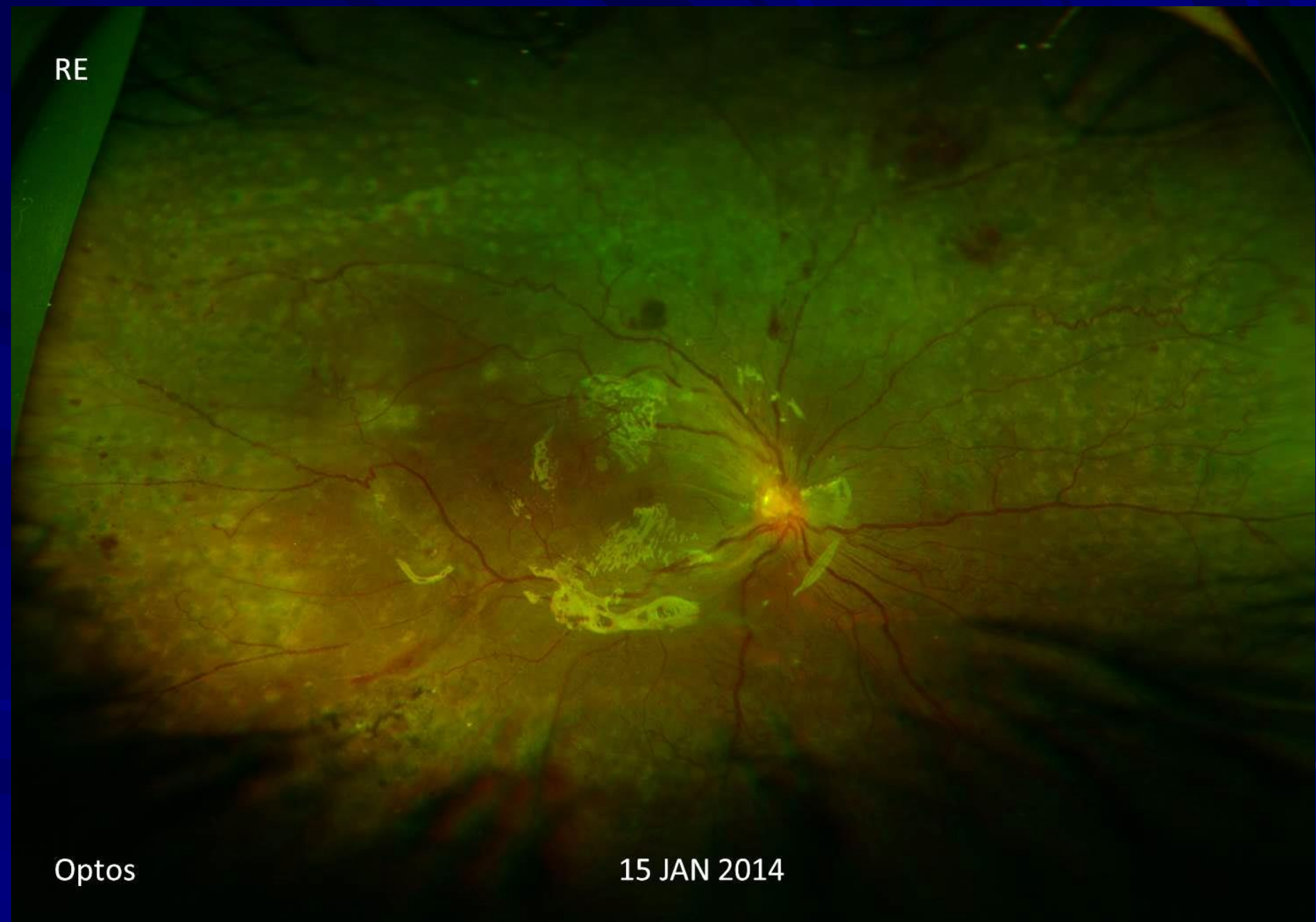
Optos

03 DEC 2013

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15 JAN 2014



Non-mydriatic Optos images have excellent agreement with dilated ETDRS photos and dilated fundus examination in determining severity of DR and DME

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Nonmydriatic Ultrawide Field Retinal Imaging Compared with Dilated Standard 7-Field 35-mm Photography and Retinal Specialist Examination for Evaluation of Diabetic Retinopathy

PAOLO S. SILVA, JERRY D. CAVALLERANO, JENNIFER K. SUN, JASON NOBLE, LLOYD M. AIELLO, AND LLOYD PAUL AIELLO

• **PURPOSE:** To compare nonmydriatic stereoscopic Optomap ultrawide field images with dilated stereoscopic Early Treatment Diabetic Retinopathy Study 7-standard field 35-mm color 30-degree fundus photographs (ETDRS photography) and clinical examination for determining diabetic retinopathy (DR) and diabetic macular edema (DME) severity.

• **DESIGN:** Single-site, prospective, comparative, instrument validation study.

• **METHODS:** One hundred three diabetic patients (206 eyes) representing the full spectrum of DR severity underwent nonmydriatic ultrawide field 100-degree and 200-degree imaging, dilated ETDRS photography, and dilated fundus examination by a retina specialist. Two independent readers graded images to determine DR and DME severity. A third masked retina specialist adjudicated discrepancies.

• **RESULTS:** Based on ETDRS photography ($n = 200$), the results were as follows: no DR ($n = 25$ eyes [12.5%]), mild nonproliferative DR (NPDR; 47 [23.5%]), moderate NPDR (61 [30.5%]), severe NPDR (11 [5.5%]), very severe NPDR (3 [1.5%]), and proliferative DR (52 [2.5%]). One (0.5%) eye was ungradable and 6 eyes did not complete ETDRS photography. No DME was found in 114 eyes (57.0%), DME was found in 28 eyes (14.0%), and clinically significant DME was found in 47 eyes (23.5%), and 11 (5.5%) eyes were ungradable. Exact DR severity agreement between ultrawide field 100-degree imaging and ETDRS photography occurred in 84%, with agreement within 1 level in 91% ($K_w = 0.85$; $K = 0.79$). Nonmydriatic ultrawide field images exactly matched clinical examination results for DR in 70% and were within 1 level in 93% ($K_w = 0.71$; $K = 0.61$). Nonmydriatic ultrawide field imaging acquisition time was less than half that of dilated ETDRS photography ($P < .0001$).

• **CONCLUSIONS:** Nonmydriatic ultrawide field images compare favorably with dilated ETDRS photography and dilated fundus examination in determining DR and DME severity; however, they are acquired more rapidly. If confirmed in broader diabetic populations, nonmydriatic ultrawide field imaging may prove to be beneficial in DR evaluation in research and clinical settings. (Am J Ophthalmol 2012;xxx:xxx. © 2012 by Elsevier Inc. All rights reserved.)

CURRENT EVIDENCE-BASED DIABETES EYE CARE IS highly effective in preserving vision and preventing vision loss from diabetic retinopathy (DR).¹⁻⁶ Because DR frequently is asymptomatic when most amenable to treatment, regular eye examination is recommended for all persons with diabetes mellitus to identify the presence and degree of DR and to initiate sight-preserving treatments as indicated. Only an estimated 60% of the diabetic population in the United States receives the recommended annual eye examination.⁷ Retinal evaluation and photography are important components of clinical care for DR and an integral element of clinical trials and telemedicine programs. Early Treatment Diabetic Retinopathy Study (ETDRS) 7-standard field 35-mm color 30-degree stereoscopic color fundus photographs (ETDRS photography) evaluated using the modified Airle House classification of diabetic retinopathy are an accepted standard for determining severity of DR.^{8,9}

Given the rapidly increasing number of patients at risk, retinal imaging of all patients is a daunting task that requires ever more rapid, readily obtained images for evaluation. Although ETDRS photography and grading protocols provide an established and documented standard for detecting and assessing severity of DR, ETDRS photography requires skilled photographers, pharmacologic pupil dilation, and traditionally, the use of 35-mm slide film. These requirements impact efficiency, convenience, and cost of the procedure. Examiners and researchers have evaluated numerous alternatives to ETDRS photography for retinal imaging and assessment of DR severity. These studies have included the use of nonmydriatic retinal cameras,¹⁰⁻¹⁴ digital video imaging,¹⁵⁻¹⁸ fewer nonstereoscopic retinal fields,¹⁹⁻²⁴ and multiple image montages.^{25,26}



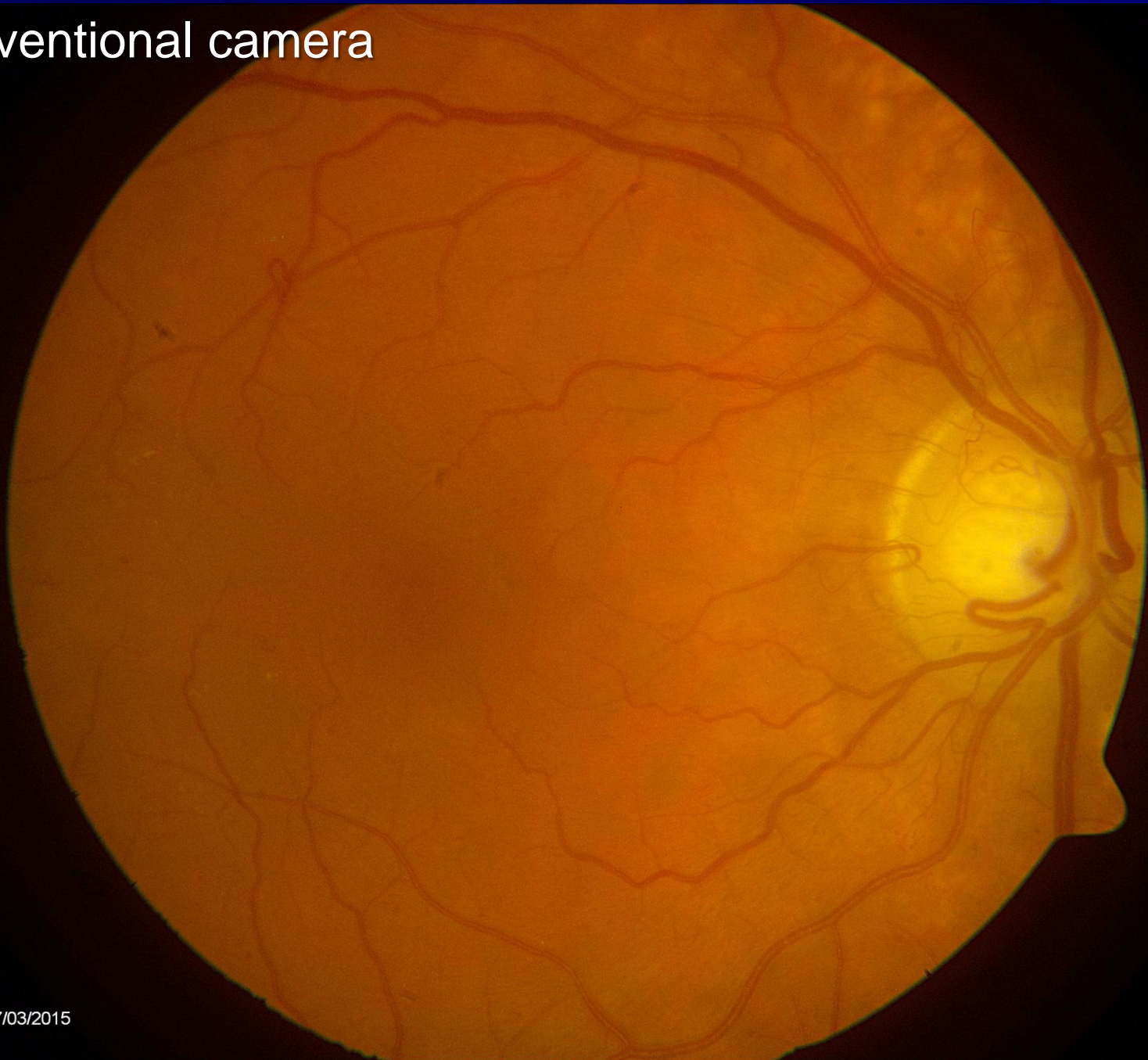
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Jason Noble is now at the Department of Ophthalmology and Vision Sciences, University of Toronto, Ontario, Canada.

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Conventional camera



OPTOS



Eidon



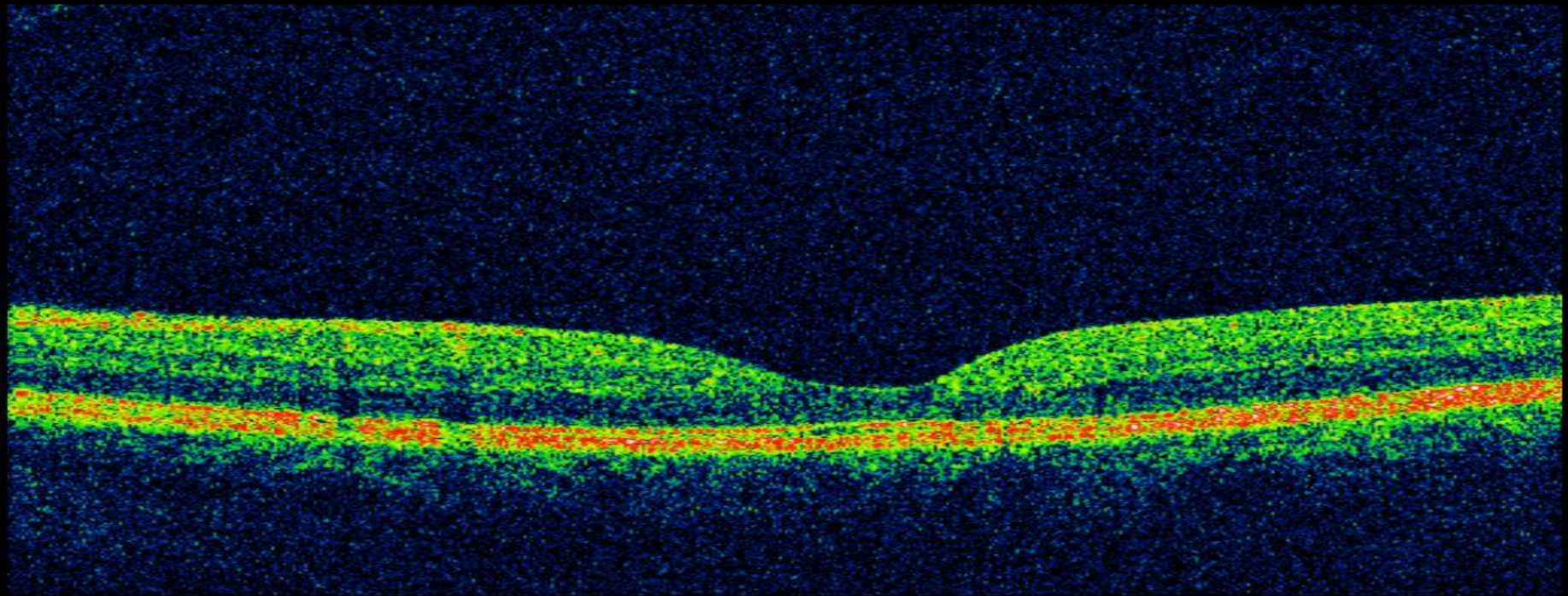
Other pathology also visualised better on multi-colour imaging



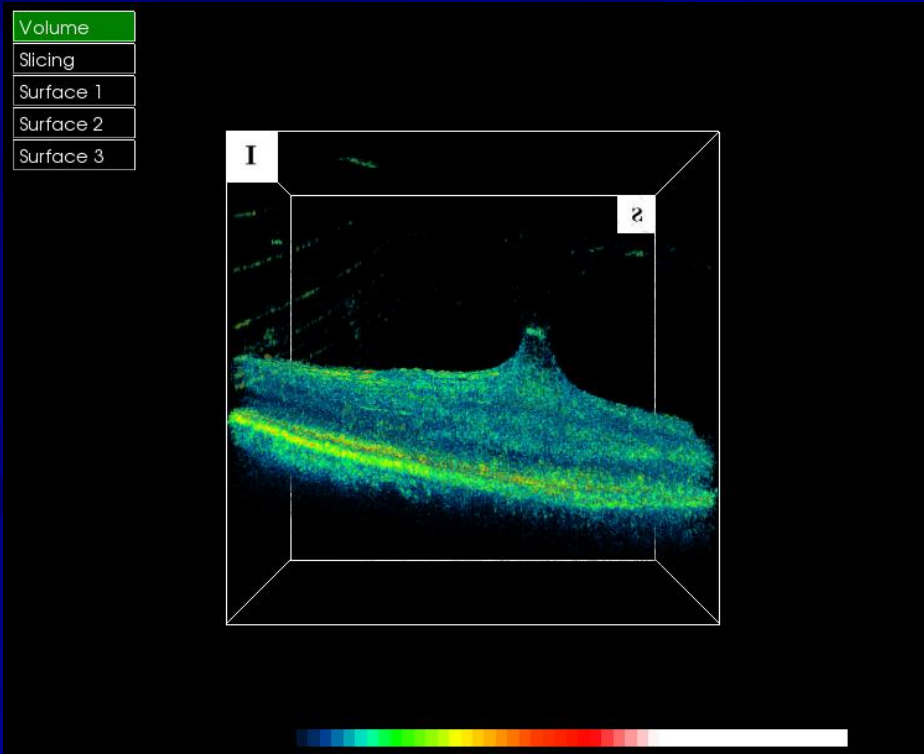
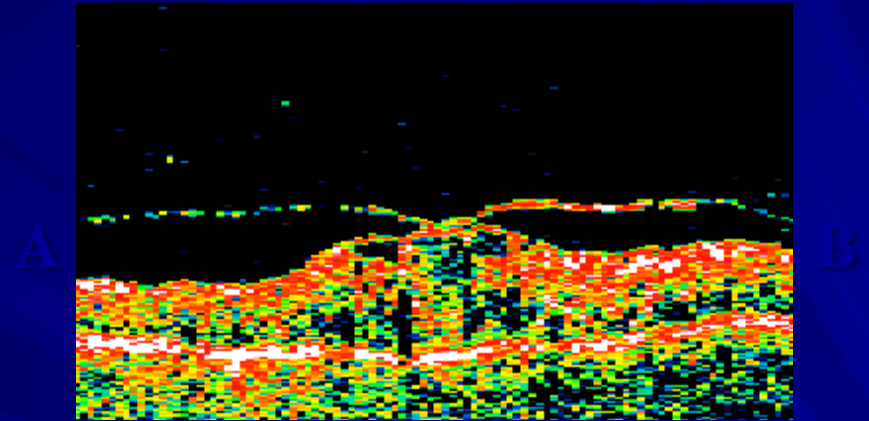
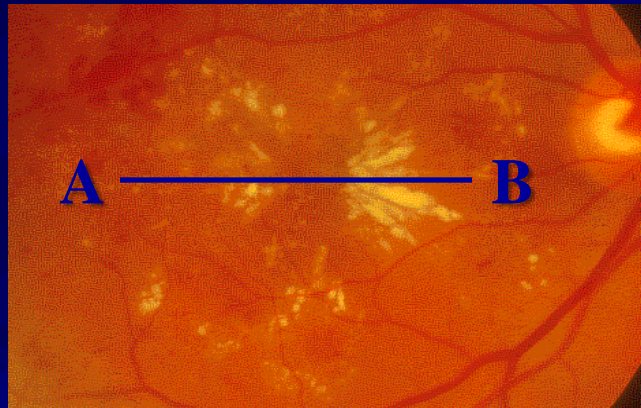
So we have to have a better understanding of the anatomy and function: cannot compromise on quality

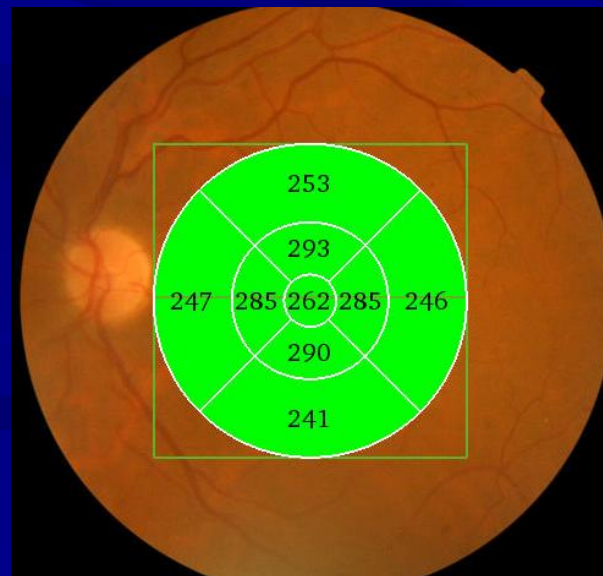
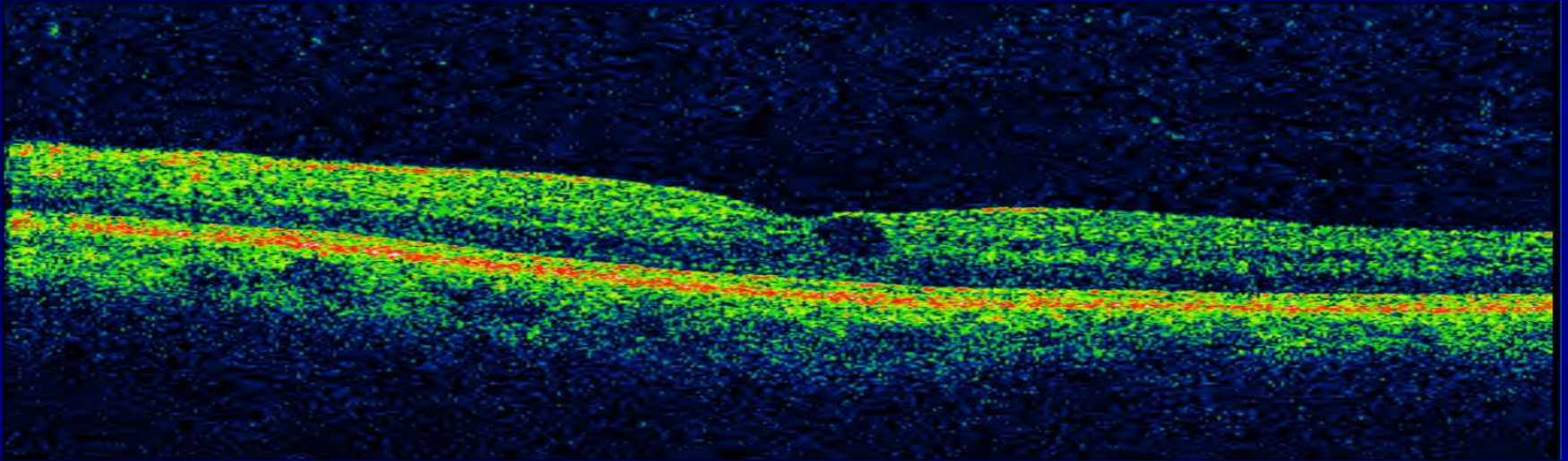
Caliper

80



Optical coherence tomography

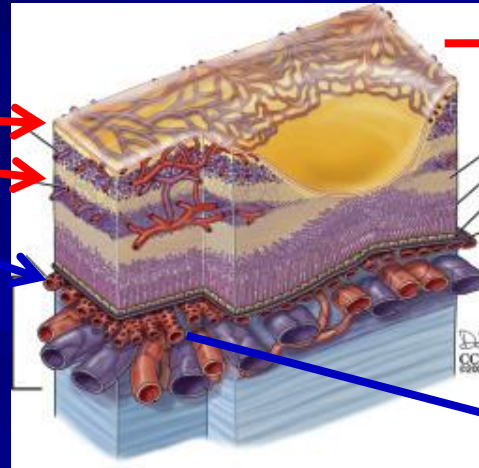
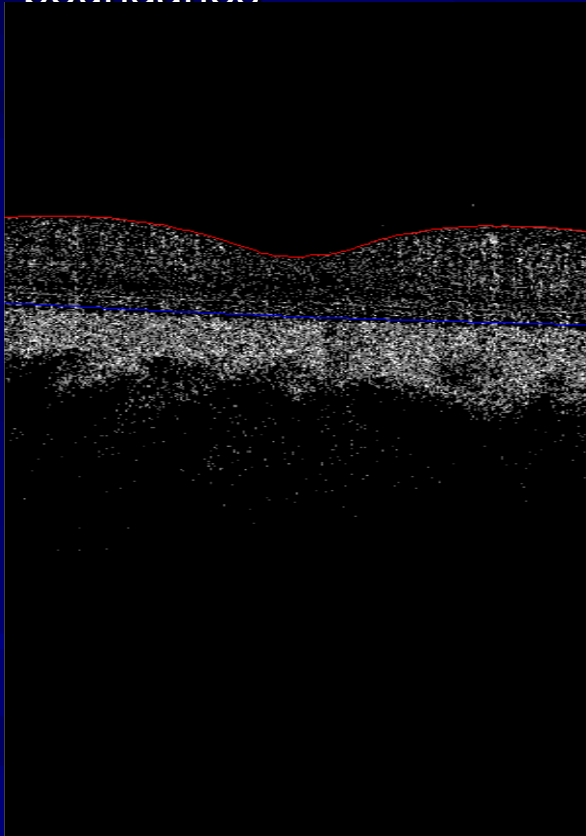




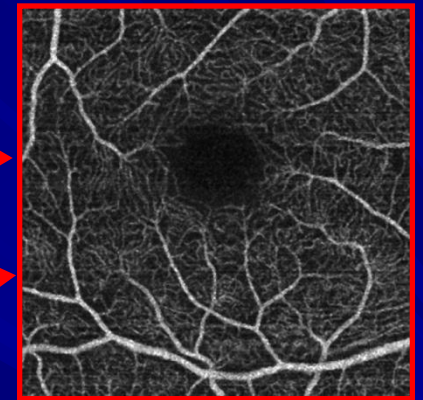
Enface OCT Angiography

Enface OCT angiography is the axial projection of 3D OCT angiography data, typically over a sub-volume encompassed between two retinal surface

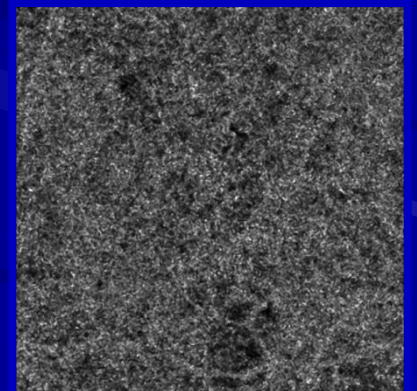
boundaries



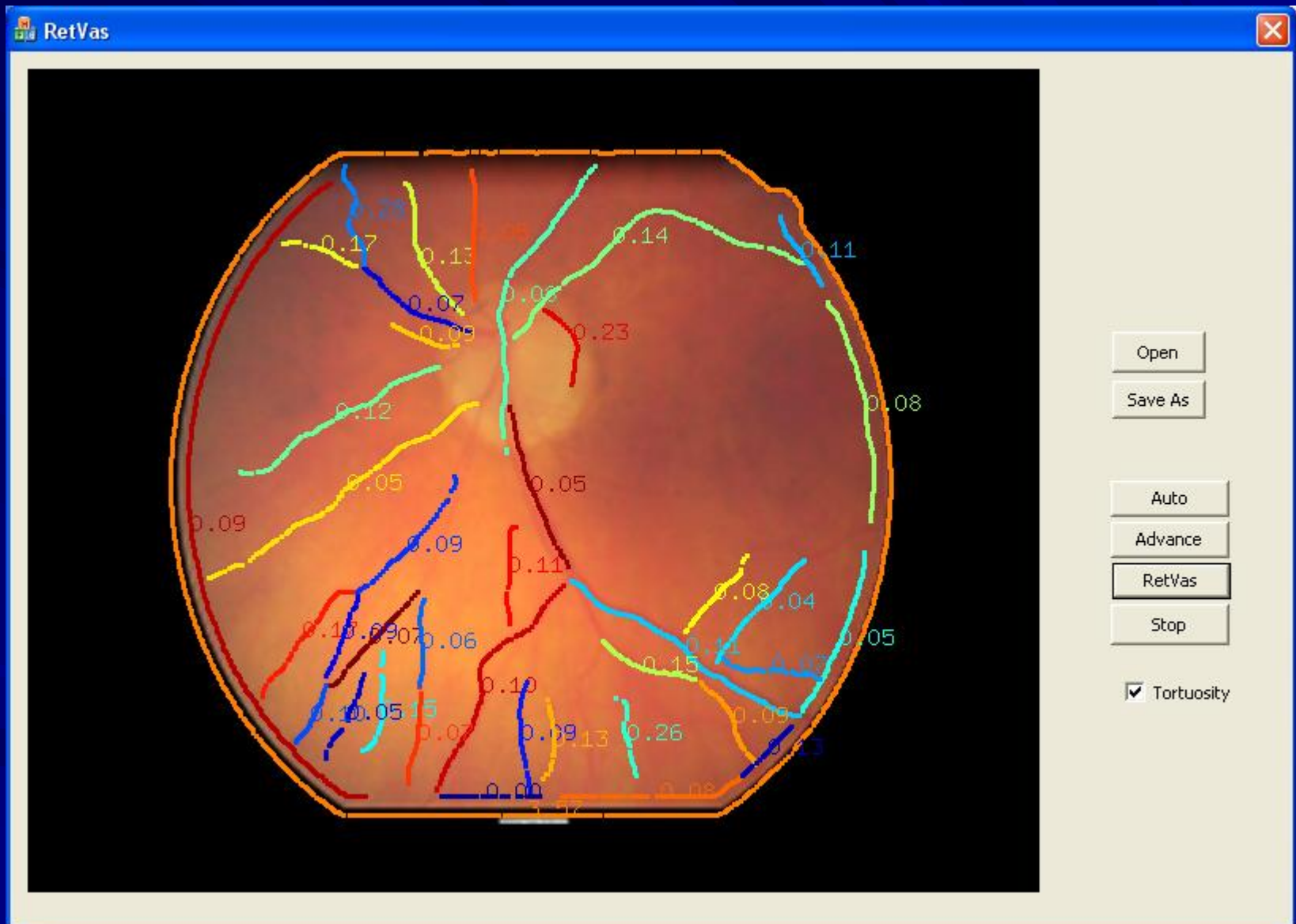
Superficial capillary plexus

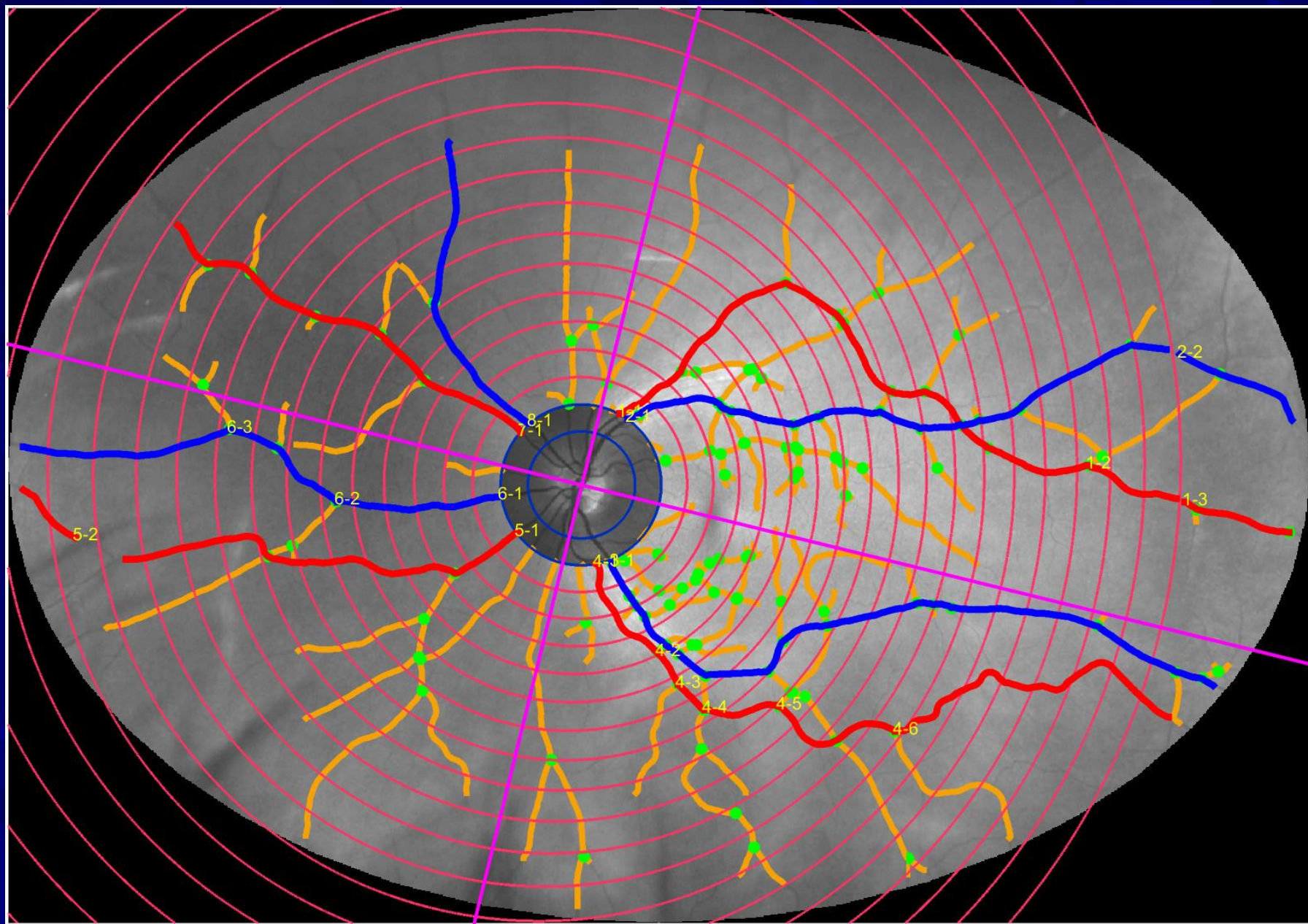


Choriocapillaris

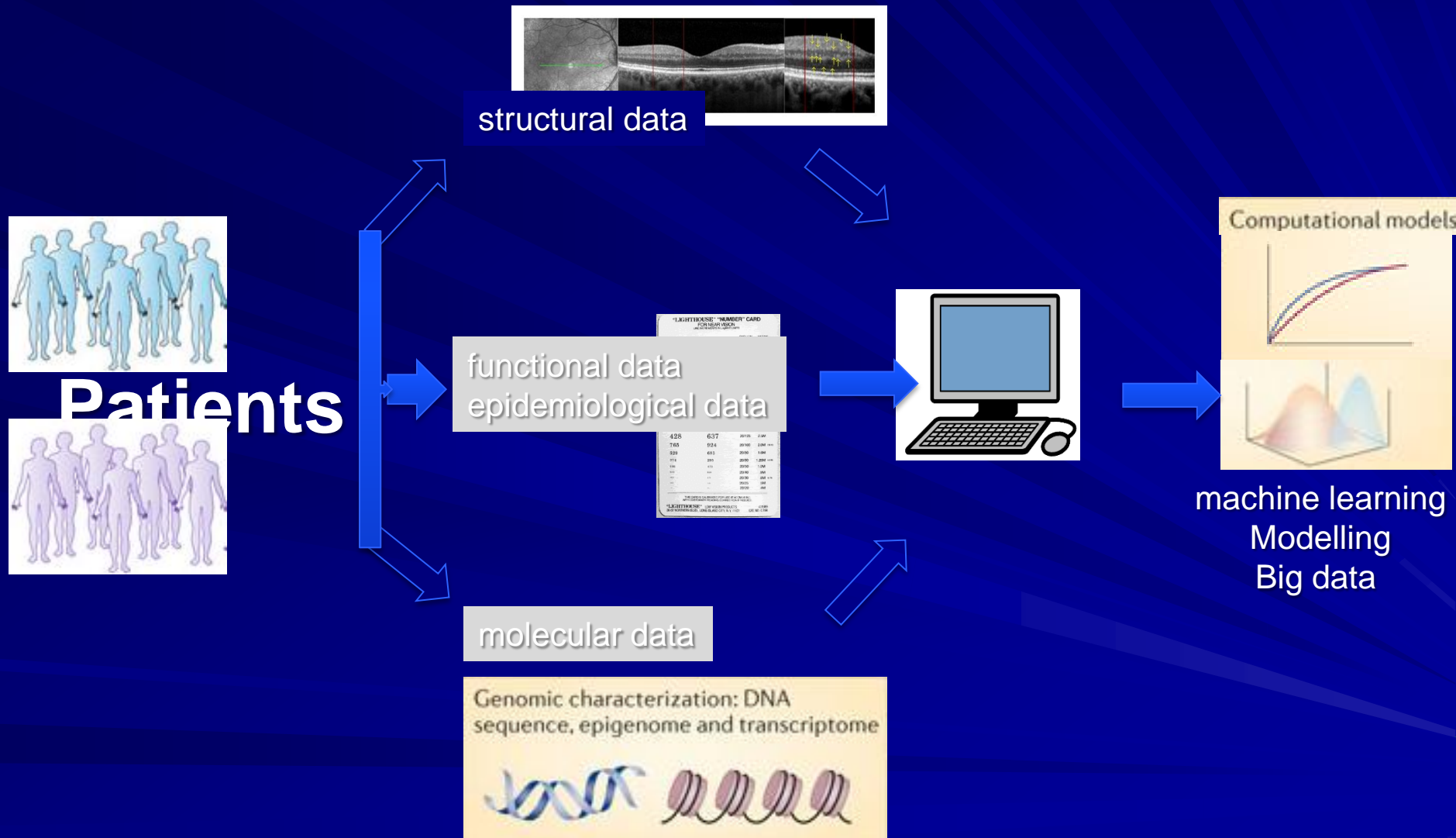


Next step: vessel measurements?





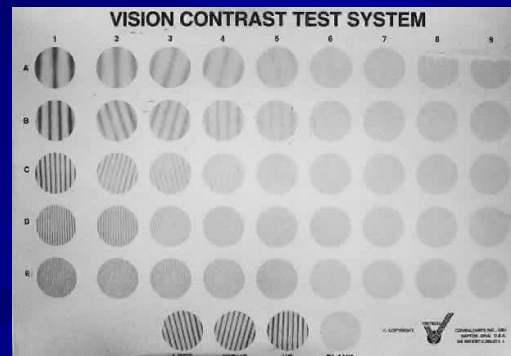
Diabetes: structural, functional, and molecular endpoints



Measuring visual acuity in patients with diabetes



- Low luminance BCdVA
- BCnVA
- Photopic microperimetry
- Dynamic eCS



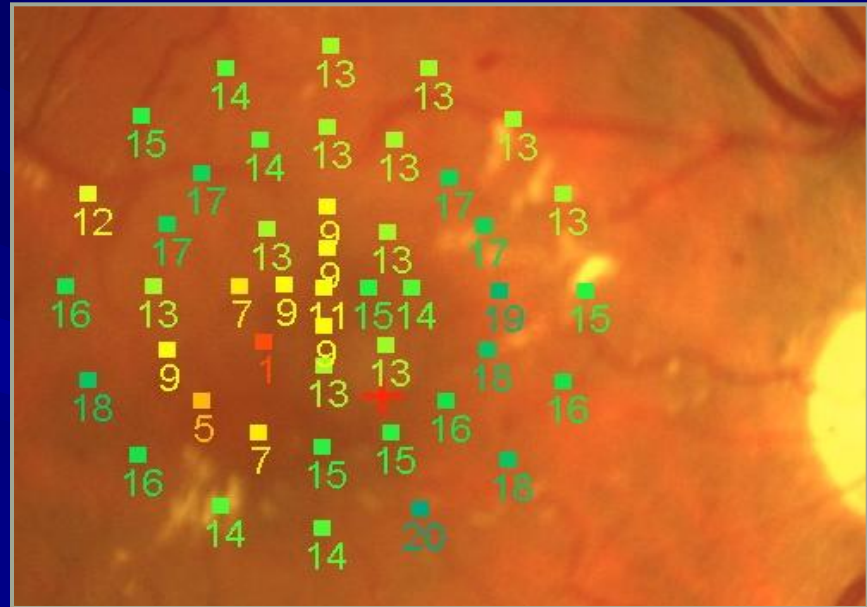
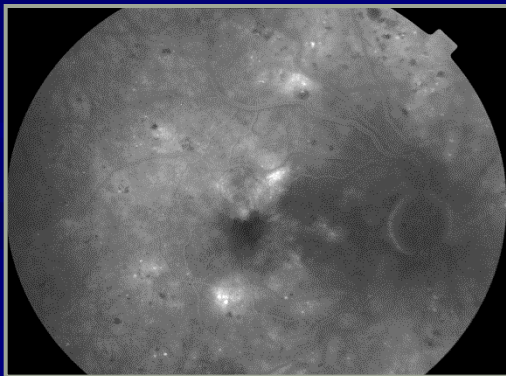
LIGHHOUSE™ "NUMBER" CARD FOR NEAR VISION LINE INCREMENTS IN LOGMAR UNITS			
		SNELLEN EQUIV- ALENT	METRIC POINT SIZE
826		20/400	8.0M
473		20/320	6.4M
952		20/250	5.0M
687	495	20/200	4.0M
359	872	20/160	3.2M
428	637	20/125	2.5M
765	924	20/100	2.0M (18 pt)
529	683	20/80	1.6M
974	295	20/60	1.25M (12 pt)
586	473	20/50	1.0M
927	629	20/40	.8M
813	479	20/30	.6M (6 pt)
847	...	20/25	.5M
...	...	20/20	.4M

THIS CARD IS CALIBRATED FOR USE AT 40 CM (16 IN.)
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Visual function quantification in diabetes

- Visual acuity (better by ETDRS charts)
- Retinal sensitivity and fixation (by microperimetry)



The microperimetry map reports (in dB) the retinal threshold of any exact tested point.

During follow-up, examination is performed over exactly the same points, thus allowing quantification of loss or gain in sensitivity



Visual Electrodiagnostic Device

This device measures the 30 Hz flicker implicit time, which has a strong correlation to retinal ischemic diseases such as diabetic retinopathy.

Design Features

- Handheld
- Utilizes skin electrodes
- Mydriatic-free
- Ultra low-noise digital amplifier

Early neuro-protection

■ EUROCONDOR Study

- Neuro-degeneration is an early process in some patients with diabetes
- RCT with neuroprotective drugs
- Current preliminary results presented at Euretina in 2017 did not show definitive results