

17TH INTERNATIONAL CONFERENCE OF THE
RESEARCH INSTITUTE OF OPHTHALMOLOGY

RIO 2025

*Anterior Segment Eye Diseases
Current Status & Future Directions*



Should Goldmann tonometry still be the gold standard?

Anthony Khawaja

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UCL Institute of Ophthalmology

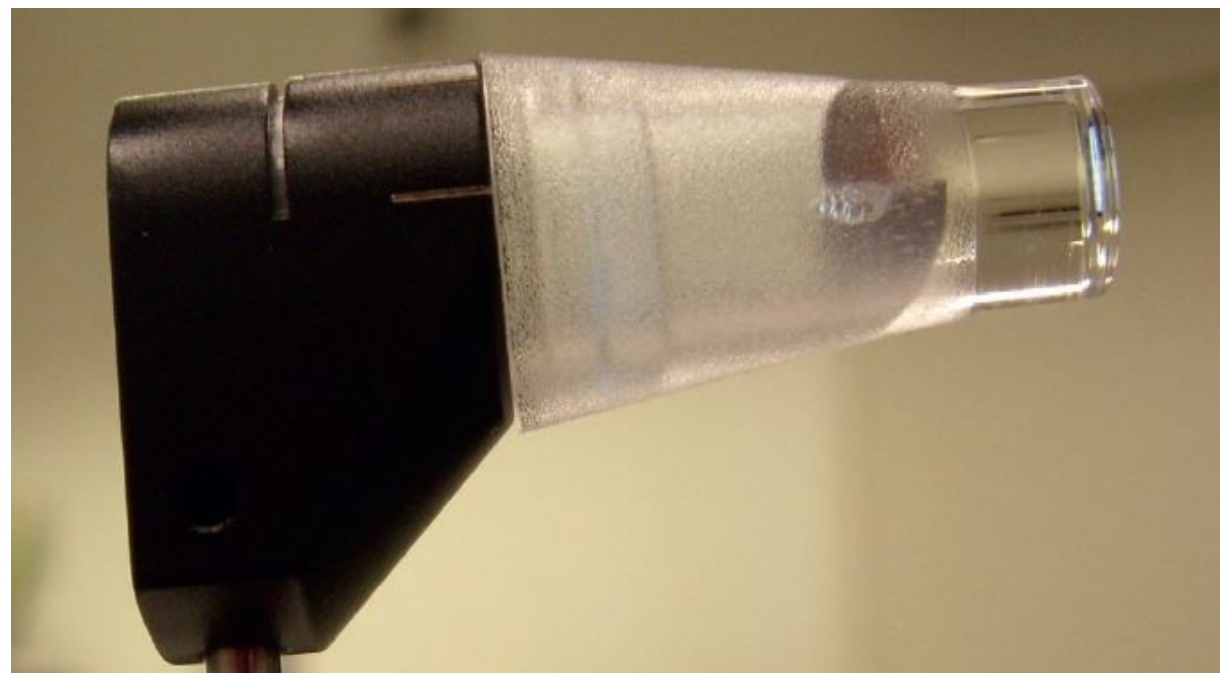


Financial disclosures

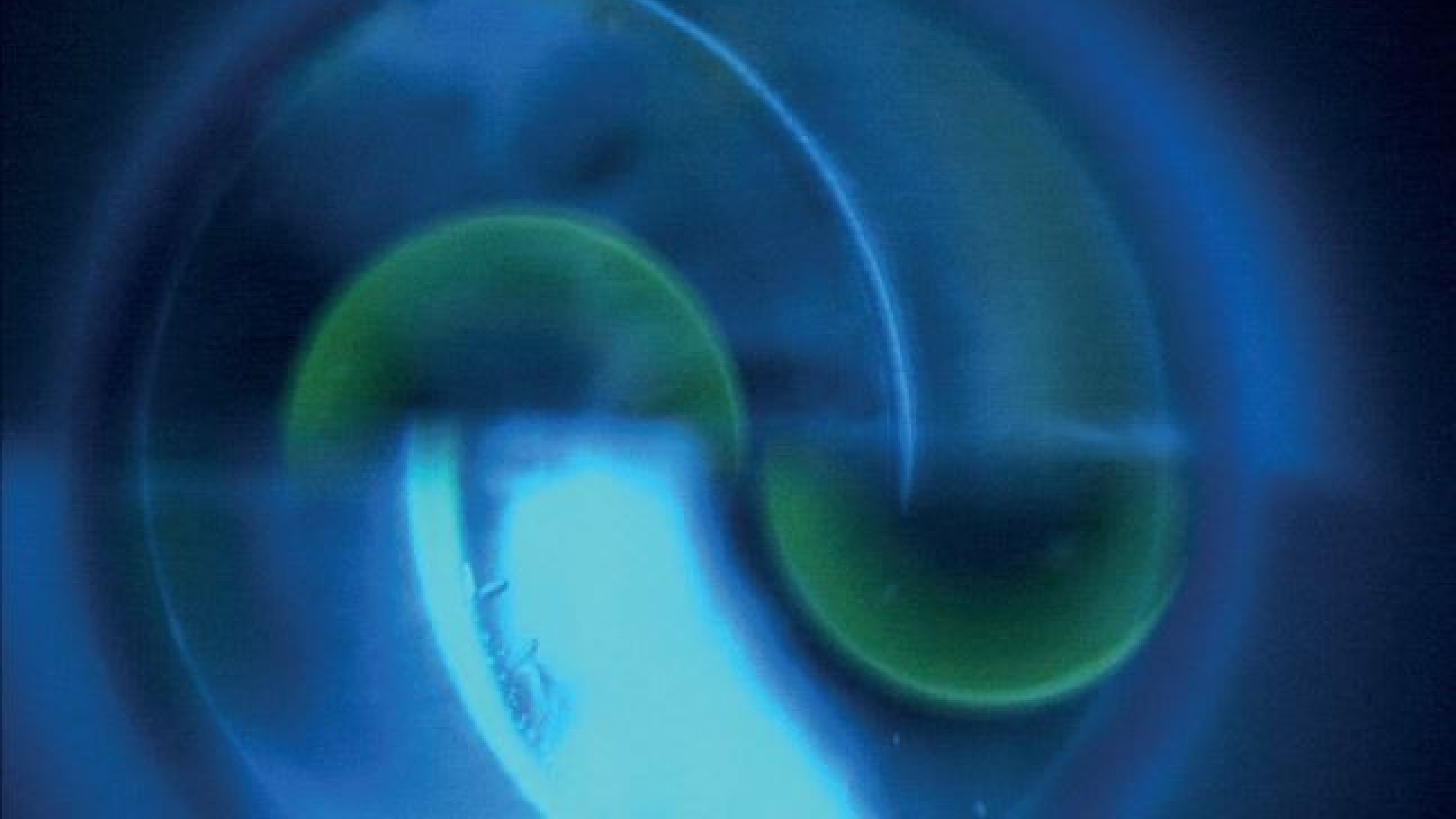
- Consultant to Aerie, Allergan, Google Health, Novartis, Reichert, Santen, Thea
- Young Investigator Award from Alcon













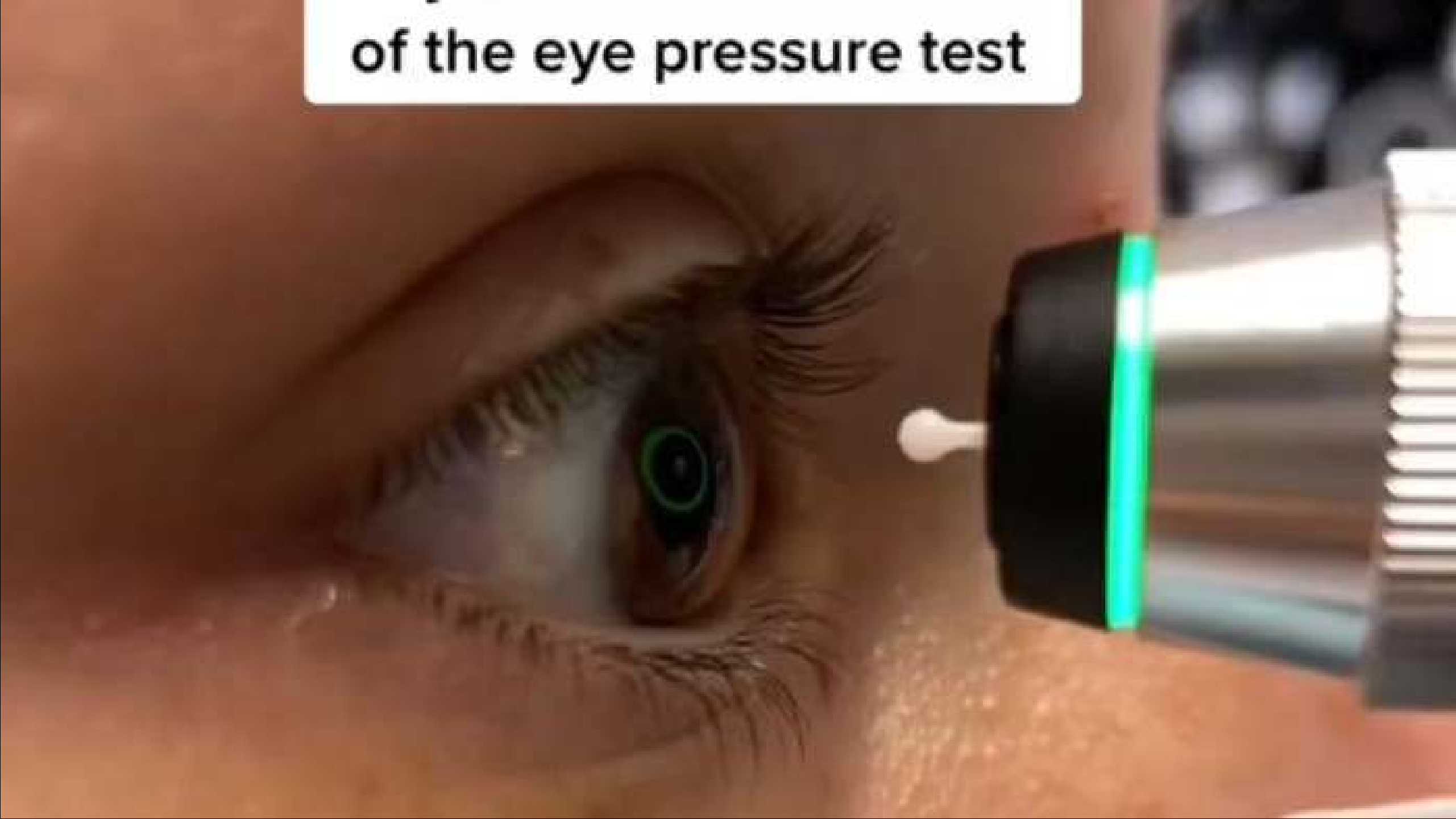
European Glaucoma Society

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of the eye pressure test

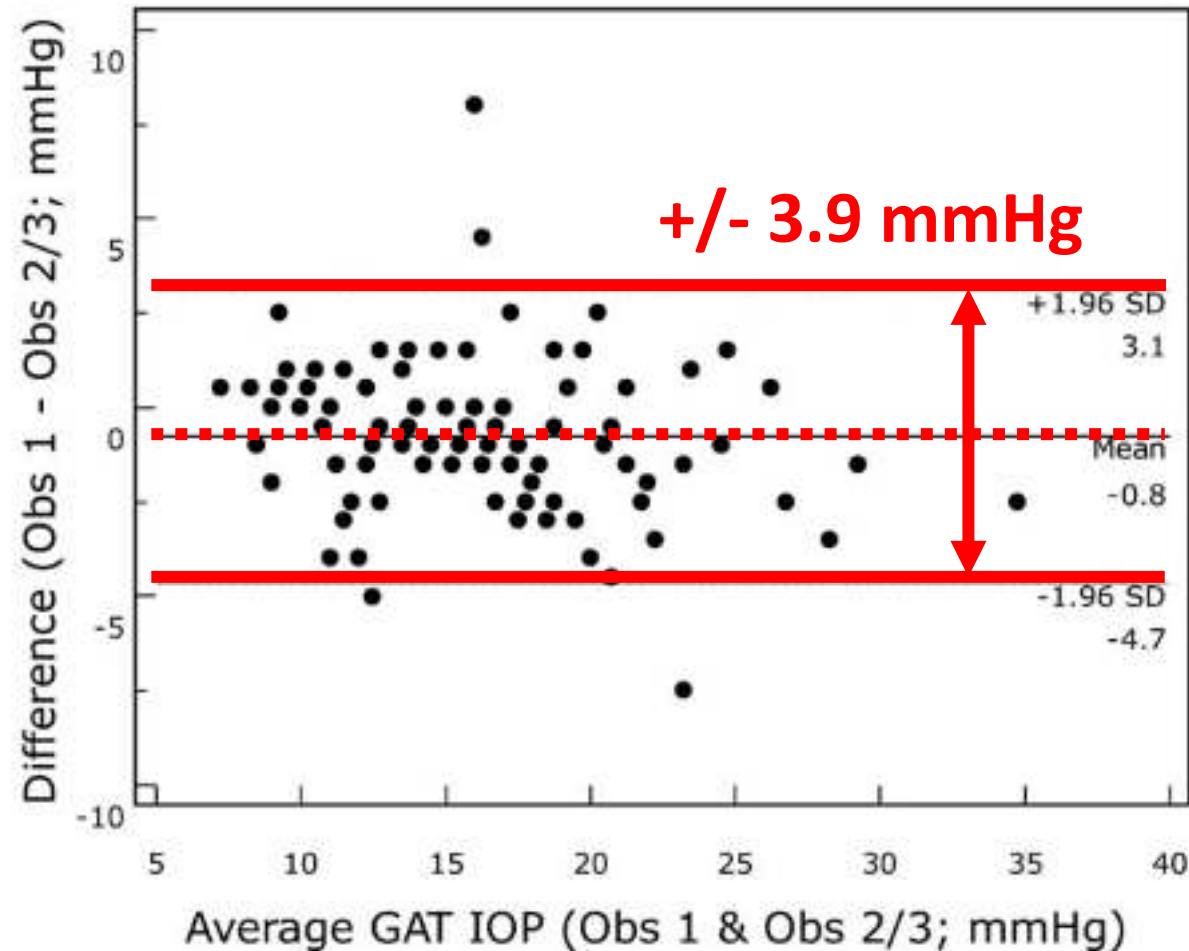




“My Goldmann pressures are never above 14 mmHg on a Friday afternoon!”

GAT - agreement

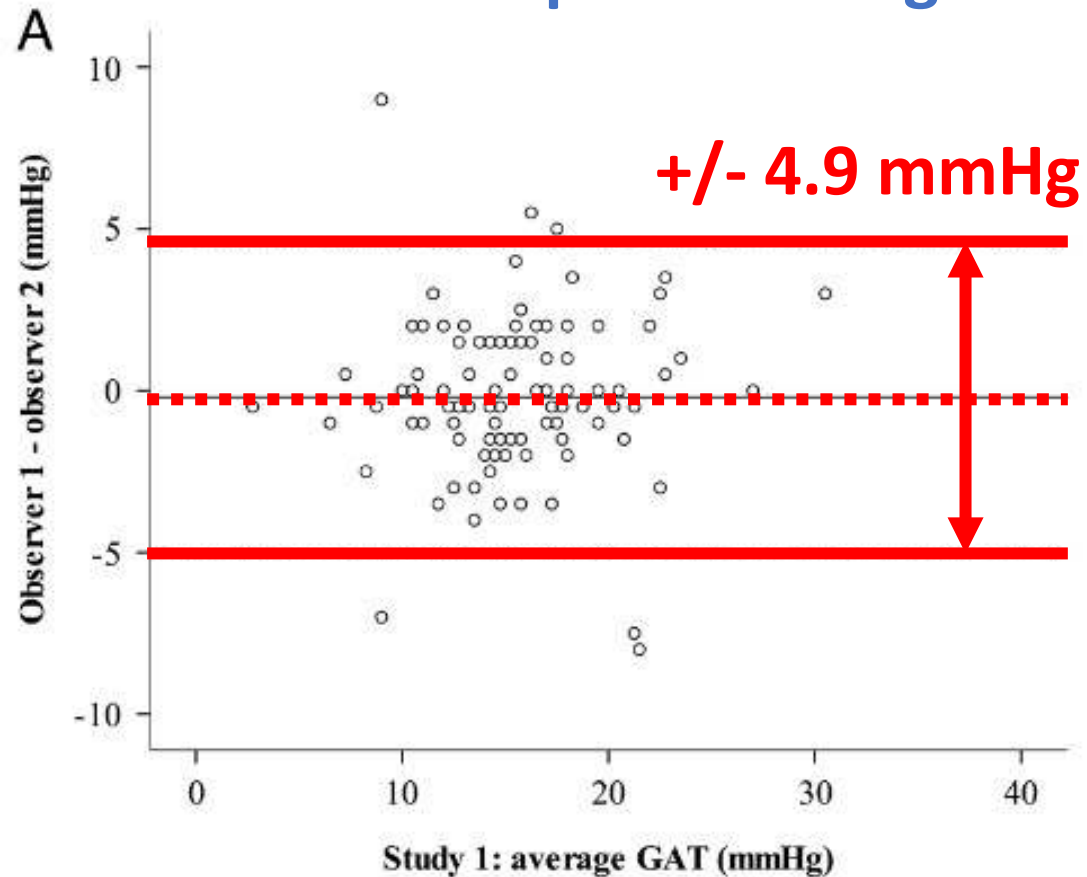
Kotecha et al. *Ophthalmology*
117, 730–737 (2010)



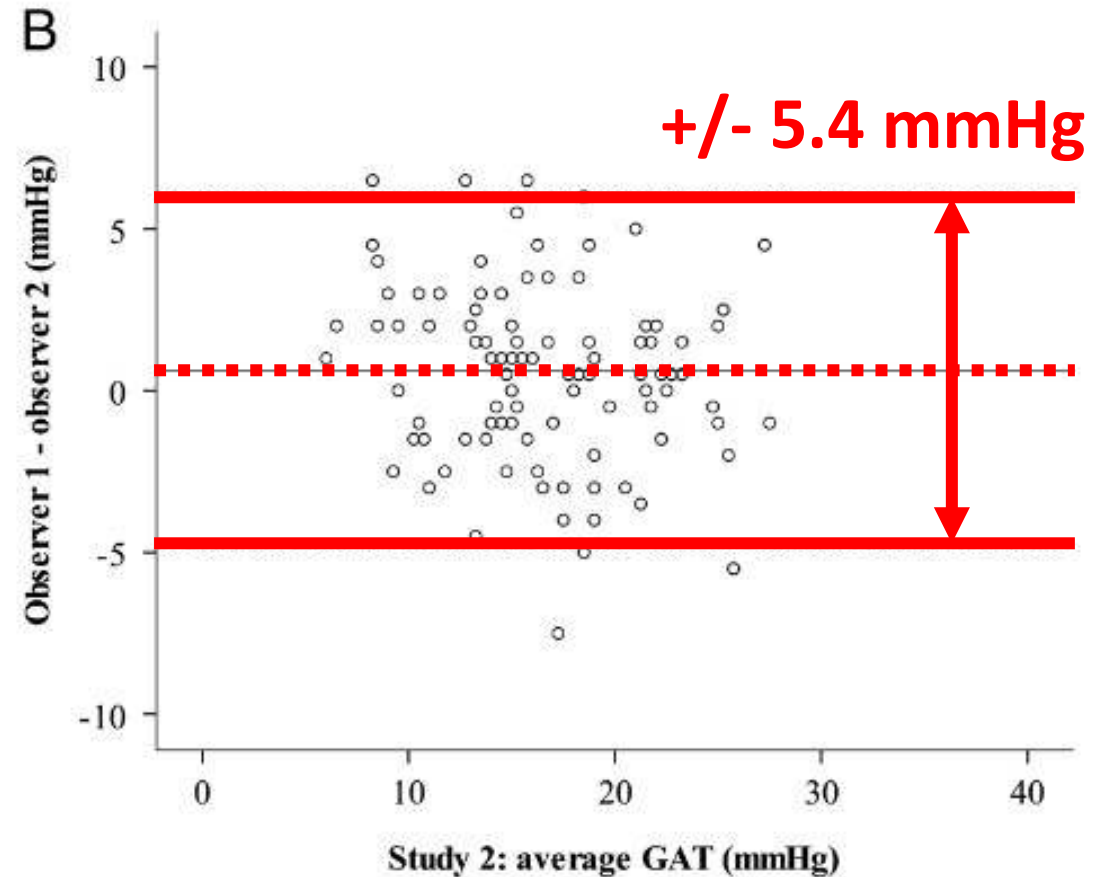
GAT - agreement

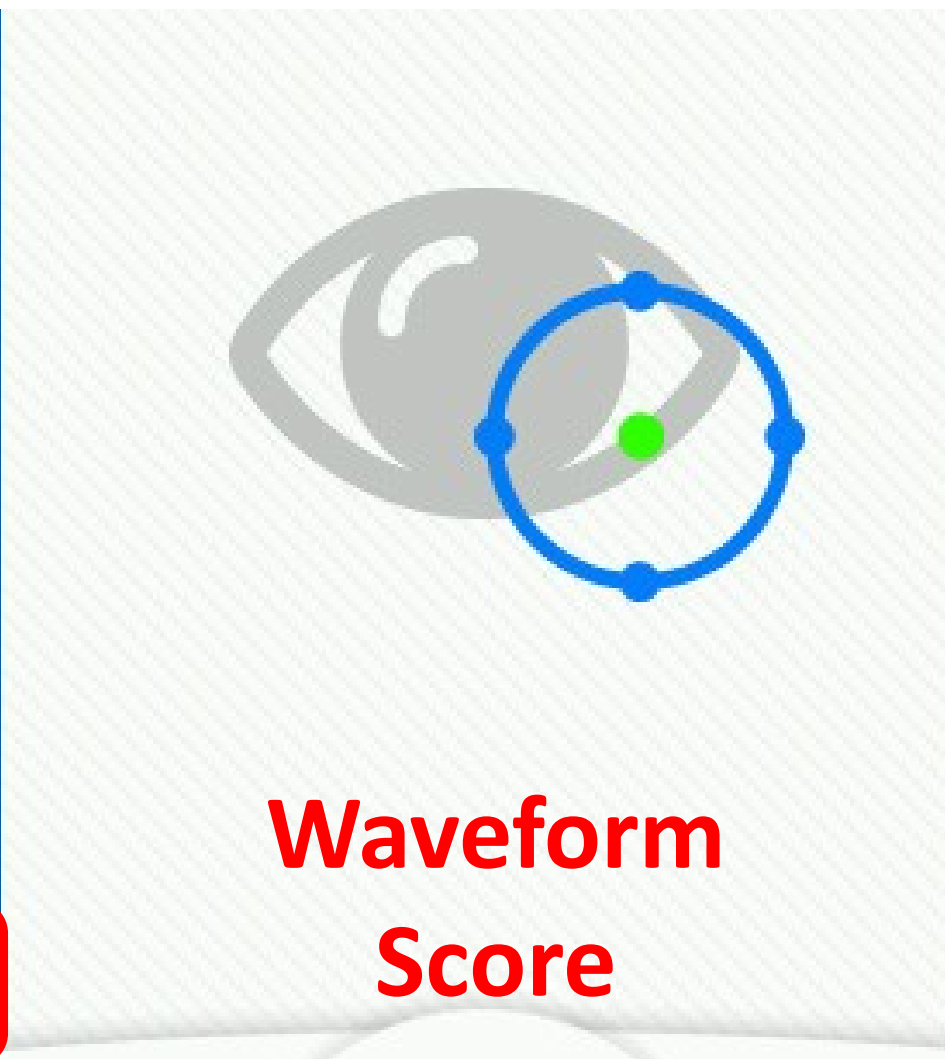
Kotecha et al. *British Journal of Ophthalmology* **100**, 854–859 (2016)

Between ophthalmologists



Between technicians







tono-vera tonometer

Reichert
ANALYTICAL
AMTEK

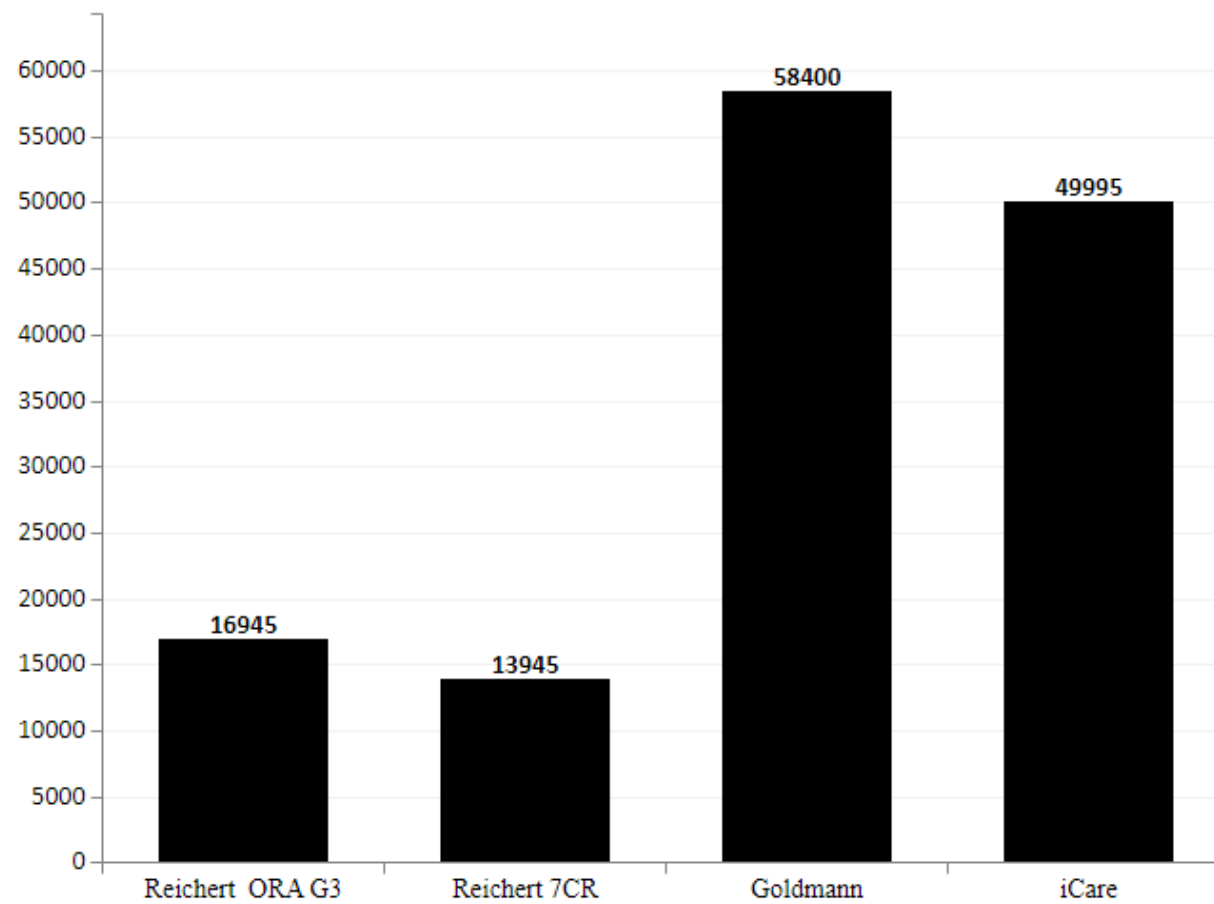


	Reichert ORA G3	Reichert 7CR	Goldmann	iCare
Cost of Device	11,995	8,995	900	2,495
Service/calibration (annual)	495	495	250	250
Disposable Prism/Tip	0	0	0.8	0.9
Anaesthetic Drop	0	0	0.2	0
Fluorescein Strip	0	0	0.1	0
Patients per week	100	100	100	100
Patients annually	5000	5000	5000	5000
One Year				
Cost per unit	£12,490	£9,490	£1,150	£2,745
Cost of Disposable items	£0	£0	£5,500	£4,500
Total cost	£12,490	£9,490	£6,650	£7,245
Ten years				
Cost per unit	£16,945	£13,945	£8,900	£9,495
Cost of Disposable items	£0	£0	£49,500	£40,500
Total cost*	£16,945	£13,945	£58,400	£49,995

*Labour costs not included

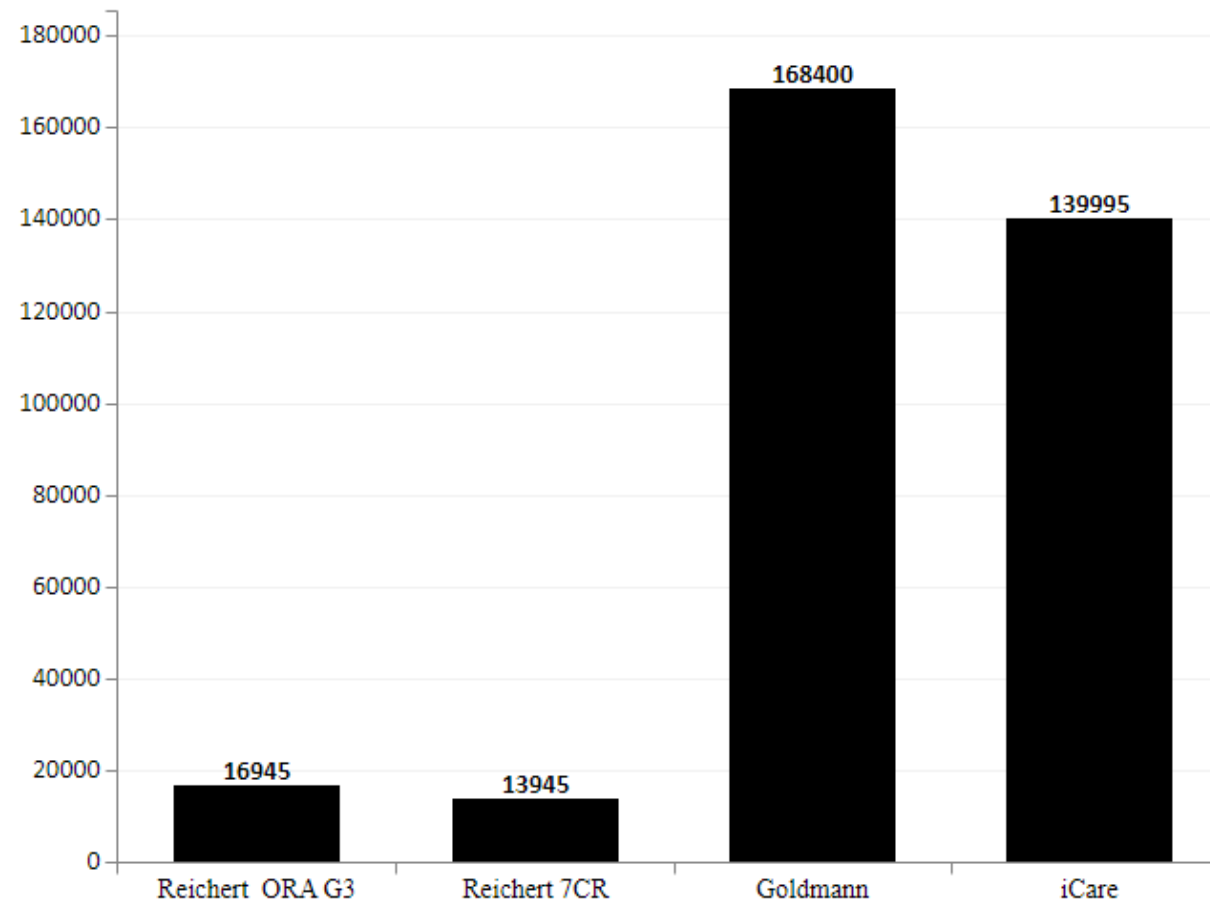
100

Total costs over 10 years*



300

Total costs over 10 years*



Moorfields costs (excl VAT)

iCare

- Probes - **£90** for 100

GAT

- Disposable tips - £59.50 for 100
- Fluorescein minims - £9.86 for 20
- Proxy minims - £13.28 for 20
- Total (1 pt/minim) = **£175.20** for 100



Potential for Collider Bias in Studies Examining the Association of Central Corneal Thickness With Glaucoma

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Sci. 2022;63(12):3.

<https://doi.org/10.1167/iovs.63.12.3>

PURPOSE. Central corneal thickness (CCT) may be biologically related to glaucoma or observed as associated with glaucoma simply due to its effect on intraocular pressure (IOP) measurement. We aimed to determine if the previously reported CCT-glaucoma associations, in which the analyses were adjusted for IOP or participants were selected on IOP, could be explained by collider bias.

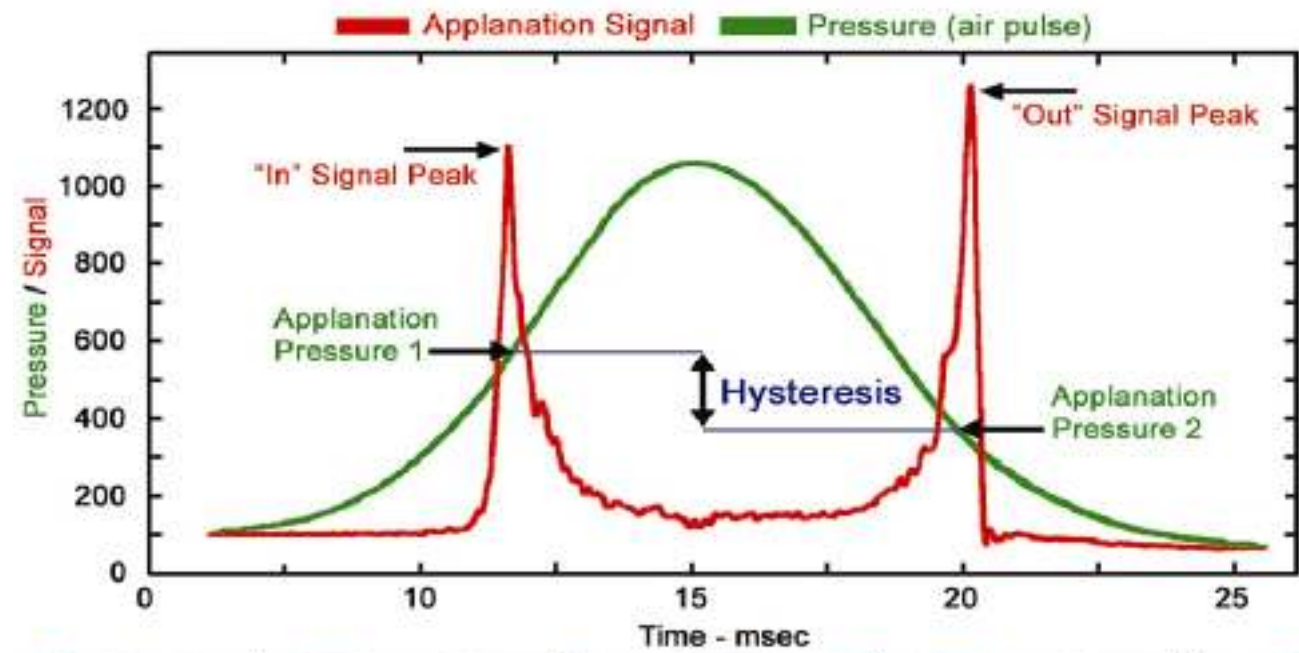
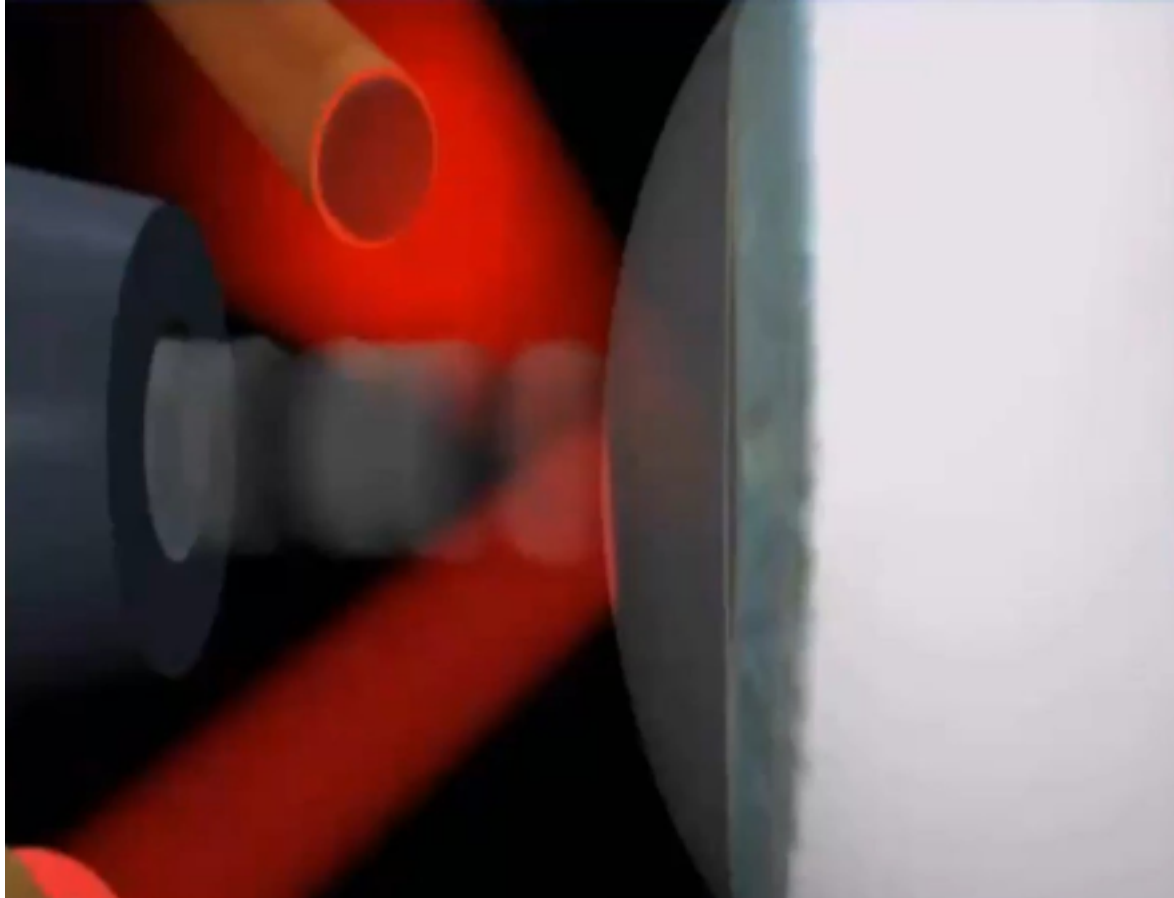
METHODS. We simulated datasets mimicking a longitudinal population-based study (Los Angeles Latino Eye Study) and a trial (Ocular Hypertension Treatment Study) such that: (i) CCT was not truly associated with glaucoma, (ii) CCT and true IOP both contribute to measured IOP, and (iii) true IOP contributes to glaucoma risk. We then tested whether an association between CCT and glaucoma could be spuriously induced simply by adjusting for or selecting on measured IOP.

RESULTS. A thinner CCT was significantly associated with higher glaucoma incidence in the simulated longitudinal population-based study when adjusted for measured IOP, but not crudely (unadjusted). A thinner CCT was crudely associated with glaucoma incidence in the simulated trial in which the participants were selected for high measured IOP. Effect sizes in the simulations were similar to those observed in the original studies.

CONCLUSIONS. Our findings question whether CCT is biologically associated with glaucoma and suggest that current evidence may be due to collider bias. This indicates that CCT alone cannot be used as a factor to identify people at high risk of glaucoma in the general population. Using CCT in combination with IOP may be superior to using IOP alone.

Ocular Response Analyzer® G3

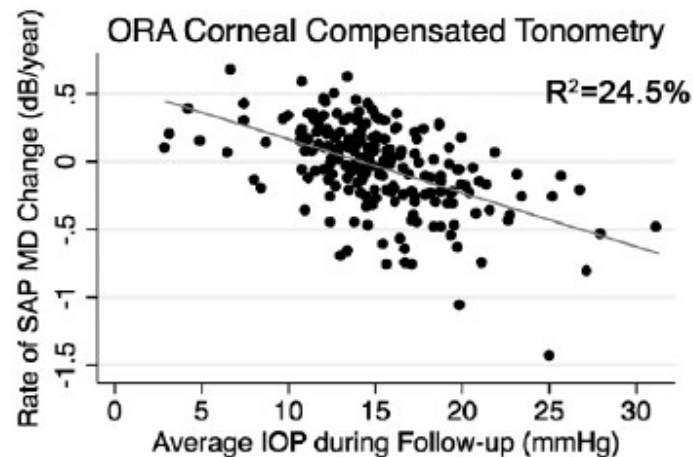
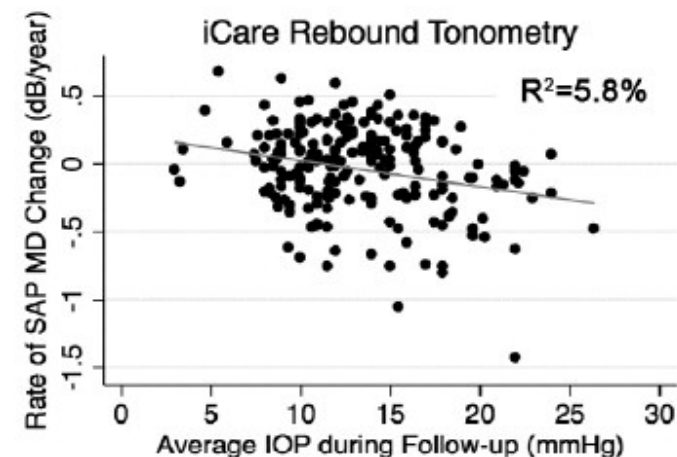
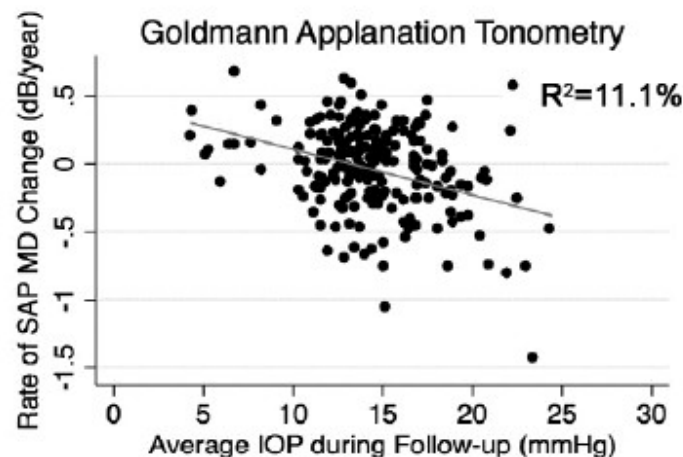




$$\text{IOP}_{\text{cc}} = m1 \cdot (P2 + k \cdot P1) + b1, \text{ for } -1 < k < +1$$

Association between Rates of Visual Field Progression and Intraocular Pressure Measurements Obtained from Different Tonometers

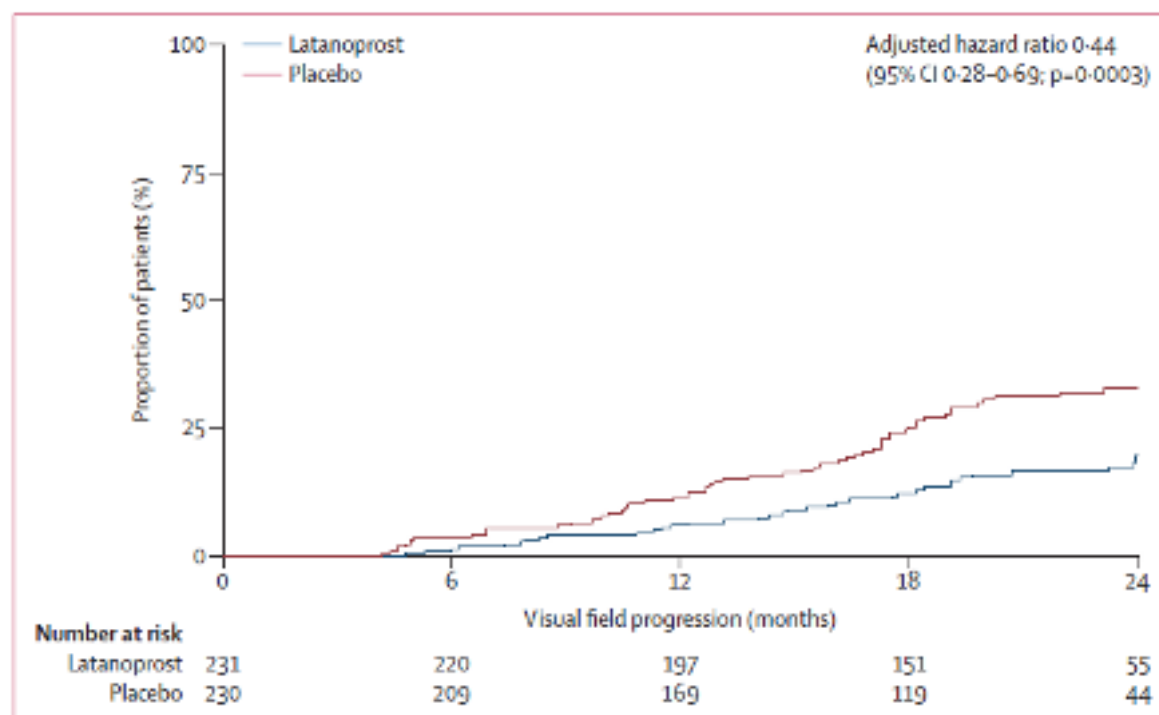
Bianca N. Susanna, MD,^{1,2,3} Nara G. Ogata, MD,¹ Fábio B. 1
Alberto Diniz-Filho, MD, PhD,² Felipe A. Medeiros, MD, PhD¹



Latanoprost for open-angle glaucoma (UKGTS): a randomised, multicentre, placebo-controlled trial

David F Garway-Heath, David P Crabb, Catey Bunce, Gerassimos Lascaratos, Francesca Amalfitano, Nitin Anand, Augusto Azuara-Blanco, Rupert R Bourne, David C Broadway, Ian A Cunliffe, Jeremy P Diamond, Scott G Fraser, Tuan A Ho, Keith R Martin, Andrew I McNaught, Anil Negi, Krishna Patel, Richard A Russell, Ameet Shah, Paul G Spry, Katsuyoshi Suzuki, Edward T White, Richard P Wormald, Wen Xing, Thierry G Zeyen

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Best predictor of progression in UKGTS?

FREE

ARVO Annual Meeting Abstract | April 2014

Intraocular pressure (IOP) measured with the Ocular Response Analyzer is a better predictor of glaucoma progression than Goldmann IOP in the United Kingdom Glaucoma Treatment Study (UKGTS).

Gerassimos Lascaratos; David F Garway-Heath; Richard A Russell; David Paul Crabb; Haogang Zhu; Cornelia Hirn; Aachal Kotecha; Katsuyoshi Suzuki; UKGTS Investigators

- **Best predictor was:**
 - **IOPcc alone**
- **Next best was:**
 - GAT + CH

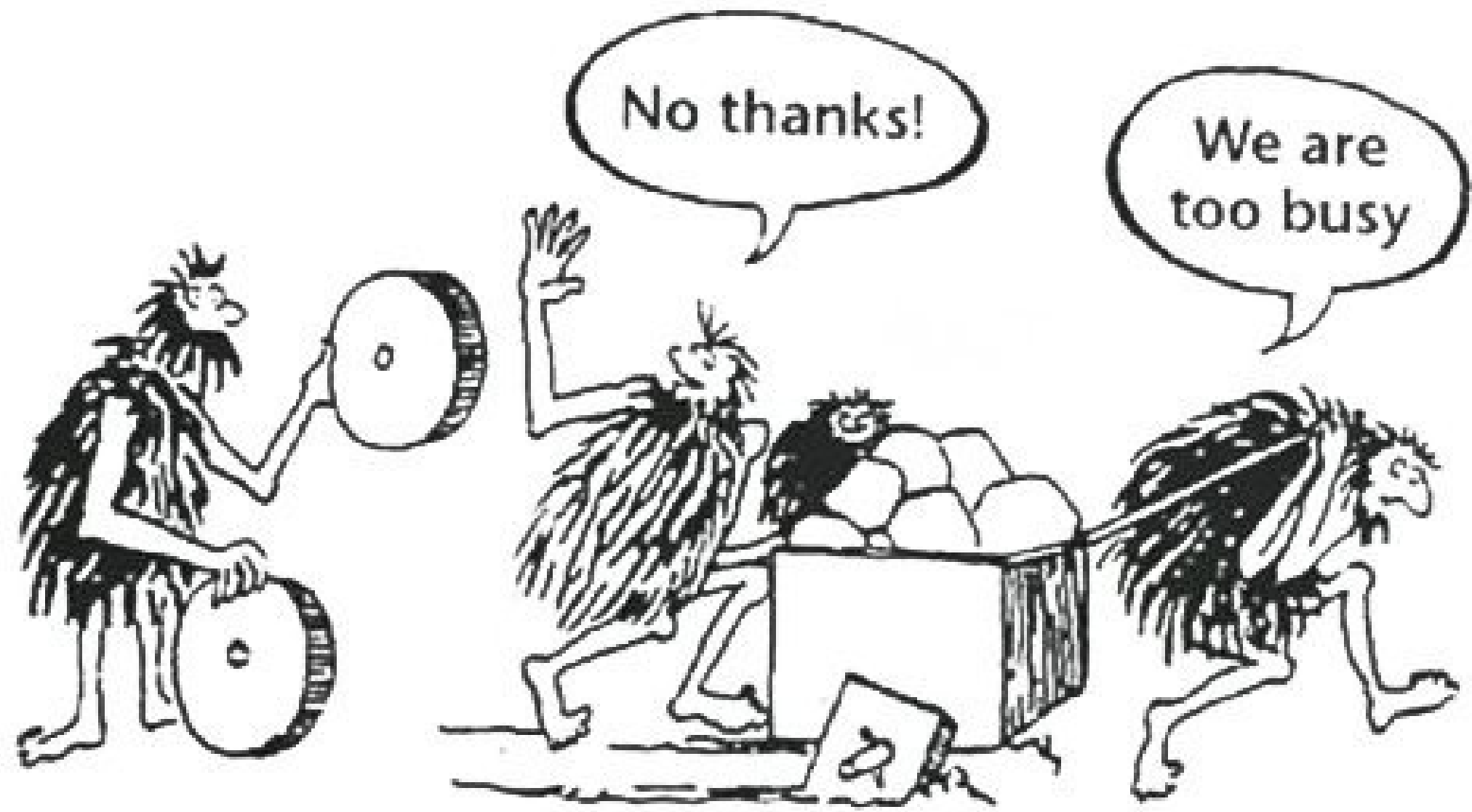
Summary

Disadvantages

- Very affected by corneal artefact
- Need drops
- Difficult; needs training
- Squeezers / narrow palp. app.
- No quality metric
- Poor reproducibility
- Plastic waste
- Expensive

Advantages

- Are there any?
- Our historic measures, just like VFs





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**TERMINOLOGY
and
GUIDELINES
for
GLAUCOMA**



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AAO





HAAG-STREIT
BERN

Swiss made

Patents for:
Britain No. 382920
U.S.A. No. 3070927
and other countries

T 9006612



...with an engraving with the
...1890 at which time he was
...It was he who explained
...the mechanism of the
...Ophthalmometer. The work of the
...Hagen and later the
...the Hagen and later the
...the Hagen and later the
...the Hagen and later the



HAAG-STREIT AG
1858-1938

Ophthalmometer
...
...



Plaster & Steel
...



1-5 CHARTER HOUSE SQUARE c.1800

1-5



The last model of
ophthalmometer shown here
is a table mounted one that
was the in the same principle
as the 1858 model.



The measurement of the curvature of the cornea is
made by approximating the reflected images of the two
retinal marks in images on the eye. This is done by
moving the targets along the arc until they touch.
Knowing the arc will determine any irregularities and
the two corneal curvatures.

The Ophthalmometer

Hermann von Helmholtz was the inventor of the first ophthalmometer
in 1855. It was used for experimental work and did not become
commercially available.

An ophthalmometer measures the radius of curvature and power
of the cornea but also the lens. A keratometer measures just the
corneal curvature.

The first ophthalmometer
glass was coated with
with silver, however.

1-10 SLIDER
This glass is used to
measure and has a
...
...

1-1 EYE DIAGNOSTIC
Used for measuring corneal curvature.
This picture was used in the
of the hospital. This instrument.

1-2 KERATOMETER
A keratometer is used to measure the
curvature of the cornea.
(1841-1875) or 1887

1-3 KERATOMETER
This was the first keratometer.
...
...

1-4 PICTURE OF CHARTER HOUSE SQUARE
This was the first keratometer.
...
...



1-3



HAAG-STREIT
BERN
Swiss made

...



1-4

Chromatophore



This instrument was invented by
Paul Chabry (1844-1911) in 1887.
It is used to measure
color vision. It consists of
...
...

2-15





Moorfields
Eye Hospital
NHS Foundation Trust



Thank you



UK Research
and Innovation

NIHR | Moorfields Biomedical
Research Centre



Moorfields
Eye Charity



The Lister Institute
of Preventive Medicine