

Weill Cornell Medical College

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Hysteresis and Intraocular Pressure of Normal, High Tension and Normal Tension Glaucoma Eyes.

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Glaucoma Dogma: GAT = IOP

- Normal mean GAT: 15 mmHg \pm 3 mmHg; normal distribution with a slight skew toward higher values
- Out side of 2nd Standard Deviation; above 21 mmHg is traditionally considered abnormally high
- IOP = 21 = Glaucoma
- GAT (= IOP)
- GAT = gold standard of IOP assessment
- High IOP = Glaucoma, low perfusion of optic nerves, giving less oxygen and nutrients

IOP (= GAT) paradoxes

- Paradox 1: GON with $GAT < 21$: Normal tension glaucoma (NTG): (different disease?, different mechanism?)
- Paradox 2: $GAT > 21$ without GON: OHT (Normal variant):
- **Therefore, IOP (= GAT) has become insignificant for glaucoma diagnosis**
- **High IOP is excluded as definition of glaucoma**

Enter CCT

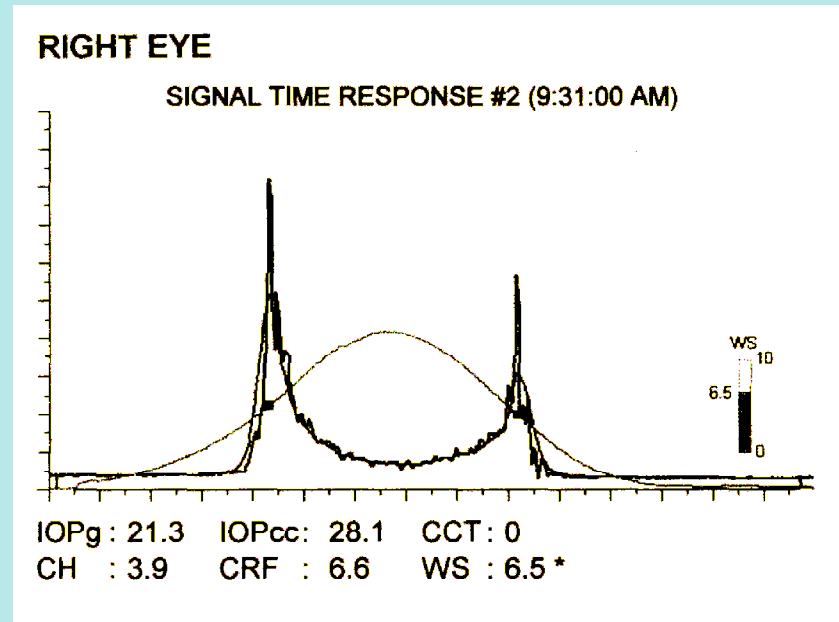
- Central Corneal Thickness (CCT) has emerged as a powerful predictor of glaucoma risk (OHTS, Barbados Eye Study, EMGT)
- However:
 - CCT is a confounder of GAT
 - Correcting GAT values for CCT is insufficient, not recommended

Ocular Response Analyzer (ORA)



Reichert's Ocular Response Analyzer (ORA) provides

- **IOP_{cc}**: IOP compensated for corneal effects
- **IOP_g**: Goldmann equivalent IOP
- **CH**: Corneal Hysteresis, a measure of viscoelasticity of the cornea (elasticity)



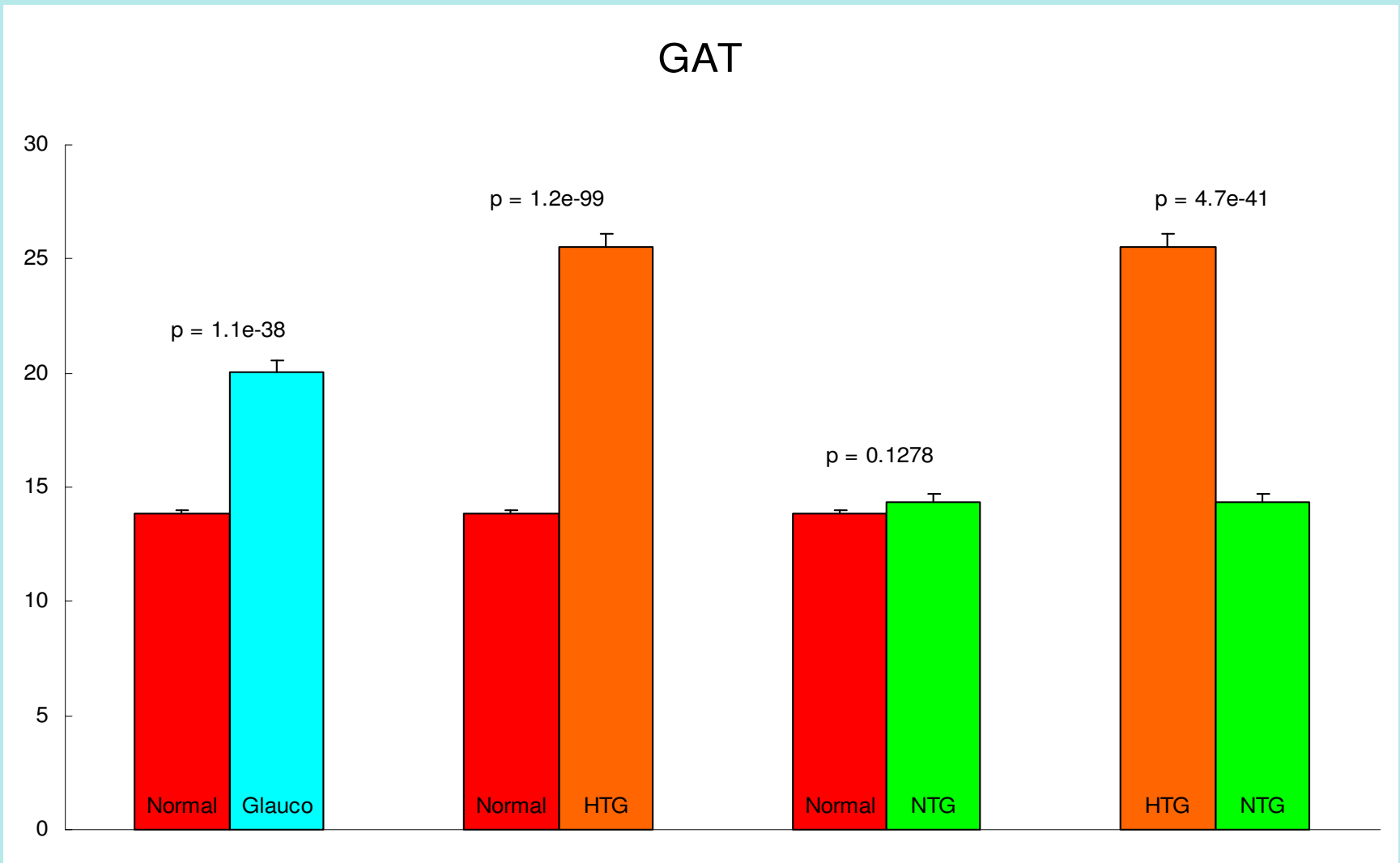
Purpose and Method

- **Purpose:** comparison of performance of GAT and IOPcc as diagnostic tests to discover glaucoma eyes
- **Method:** Chart review of consecutive **new patients**
- Glaucoma is defined by presence (+) of **glaucomatous optic neuropathy (GON)** with optic nerve and nerve fiber layer changes with or without visual field changes
- Highest recorded IOP of one eye of each patient **without previous glaucoma treatment** are included

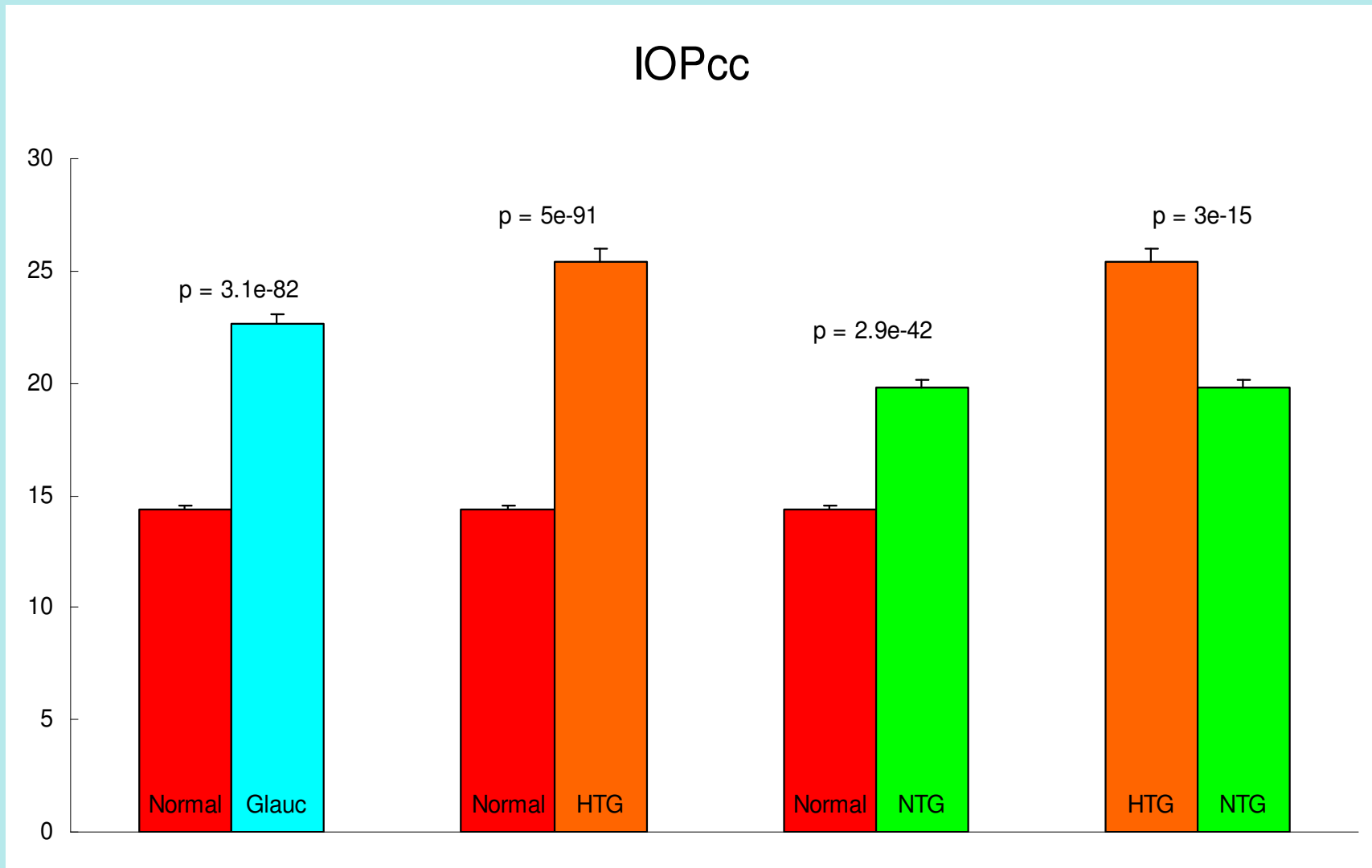
Demography: Glaucoma Subdivided to HTG and NTG

Category	Normal	Glaucoma	HTG	NTG
Subgroup	GON (-)	GON (+)	GAT \geq 21	GAT < 21
No of eyes	733	257	155 (60%)	102 (40%)
Male	317	105	57	48
Female	416	152	98	54
OD	363	122	78	44
OS	370	135	77	58
Asian	166	34	23	11
Caucasian	204	74	47	27
Mixed	278	80	51	29
Black	84	77	34	43

GAT comparison



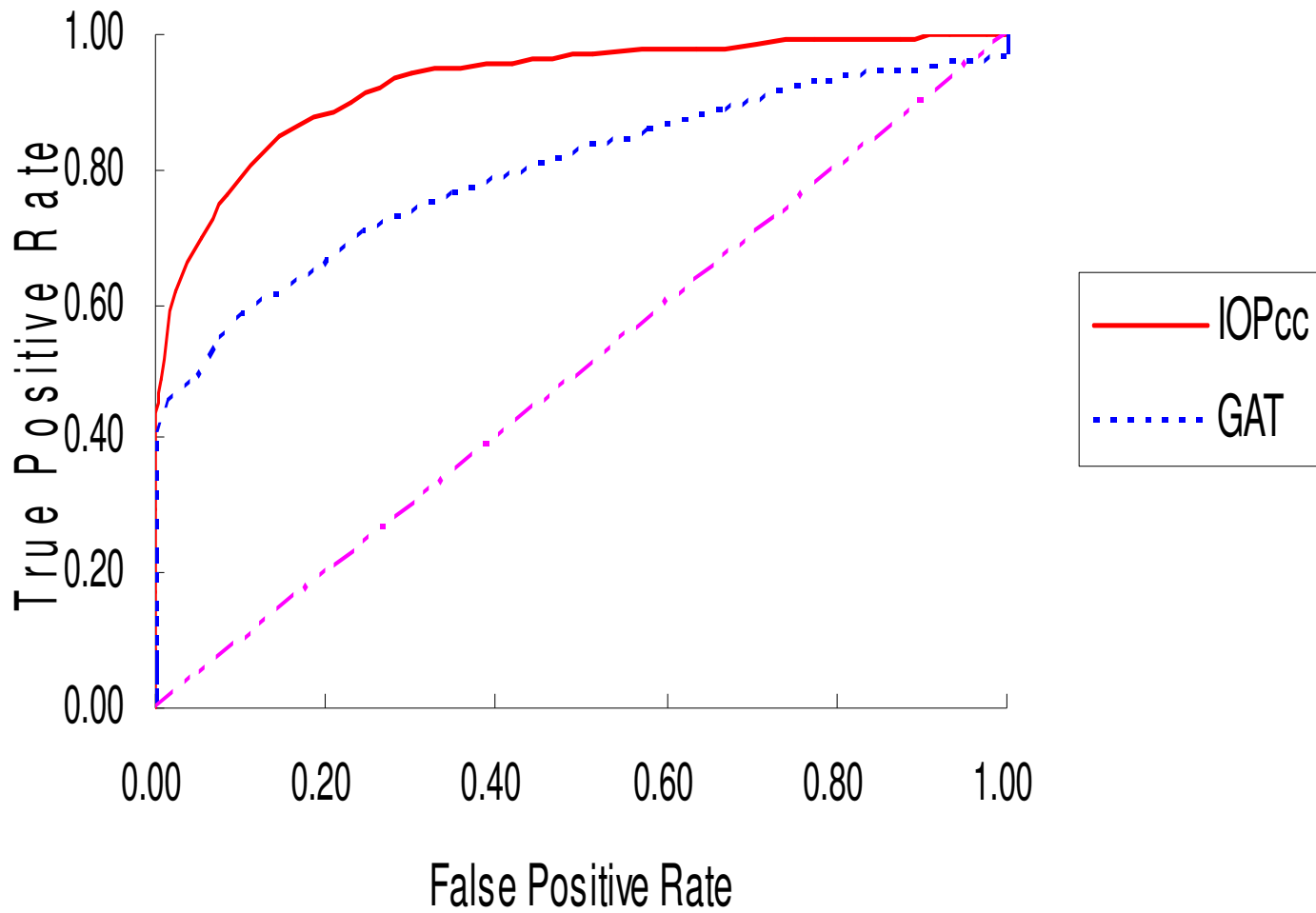
IOPcc comparison



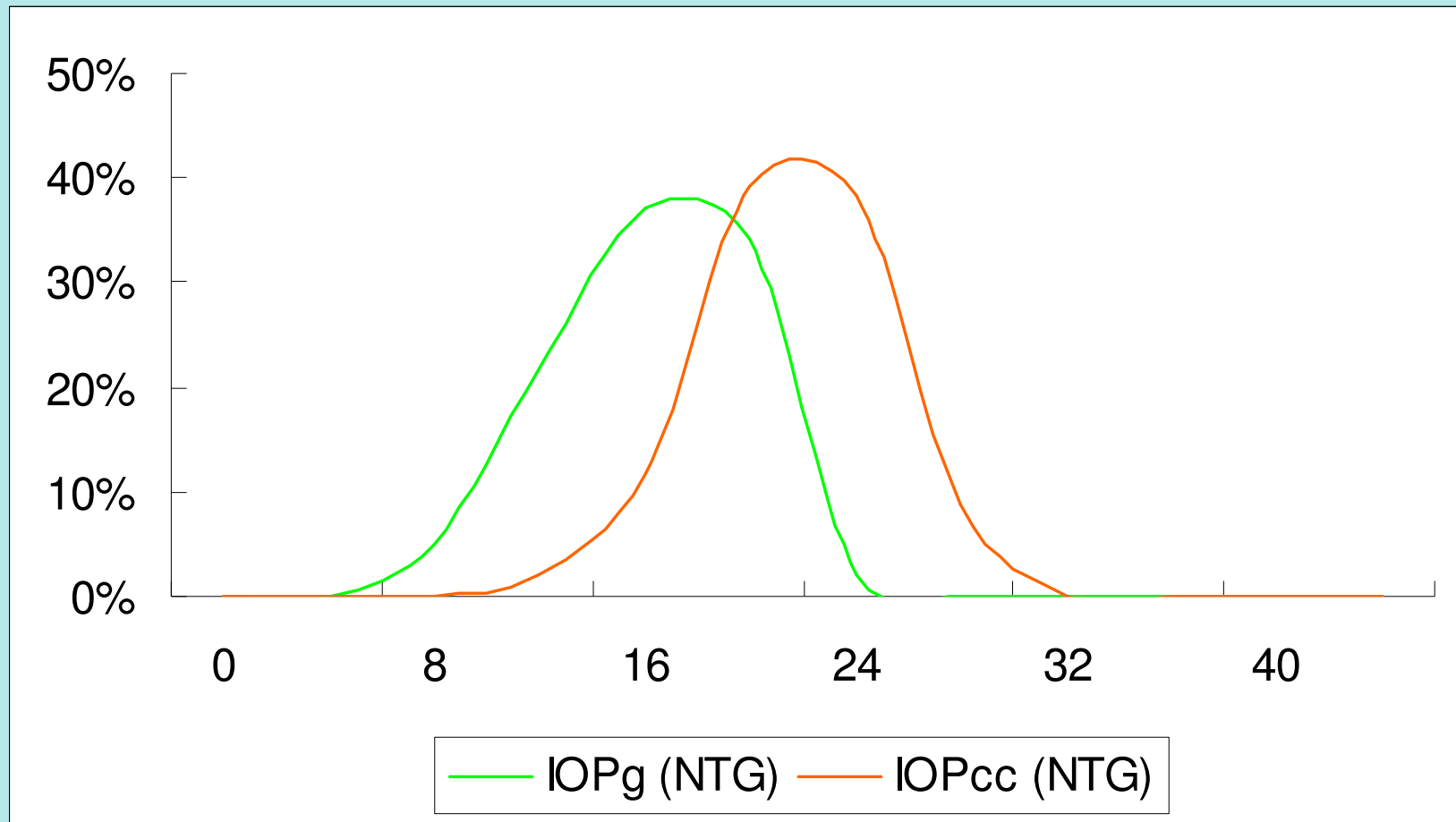
Comparison of Sensitivity and Specificity of **GAT** versus **IOPcc**

Threshold	Sensitivity	Specificity	Mean of Sen + Spe	Product Sen * Spe
GAT 18	71% (29%)	90% (10%)	74%	53%
IOPcc 18	85% (15%)	85% (15%)	85%	72%

Receiver Operating Characteristic



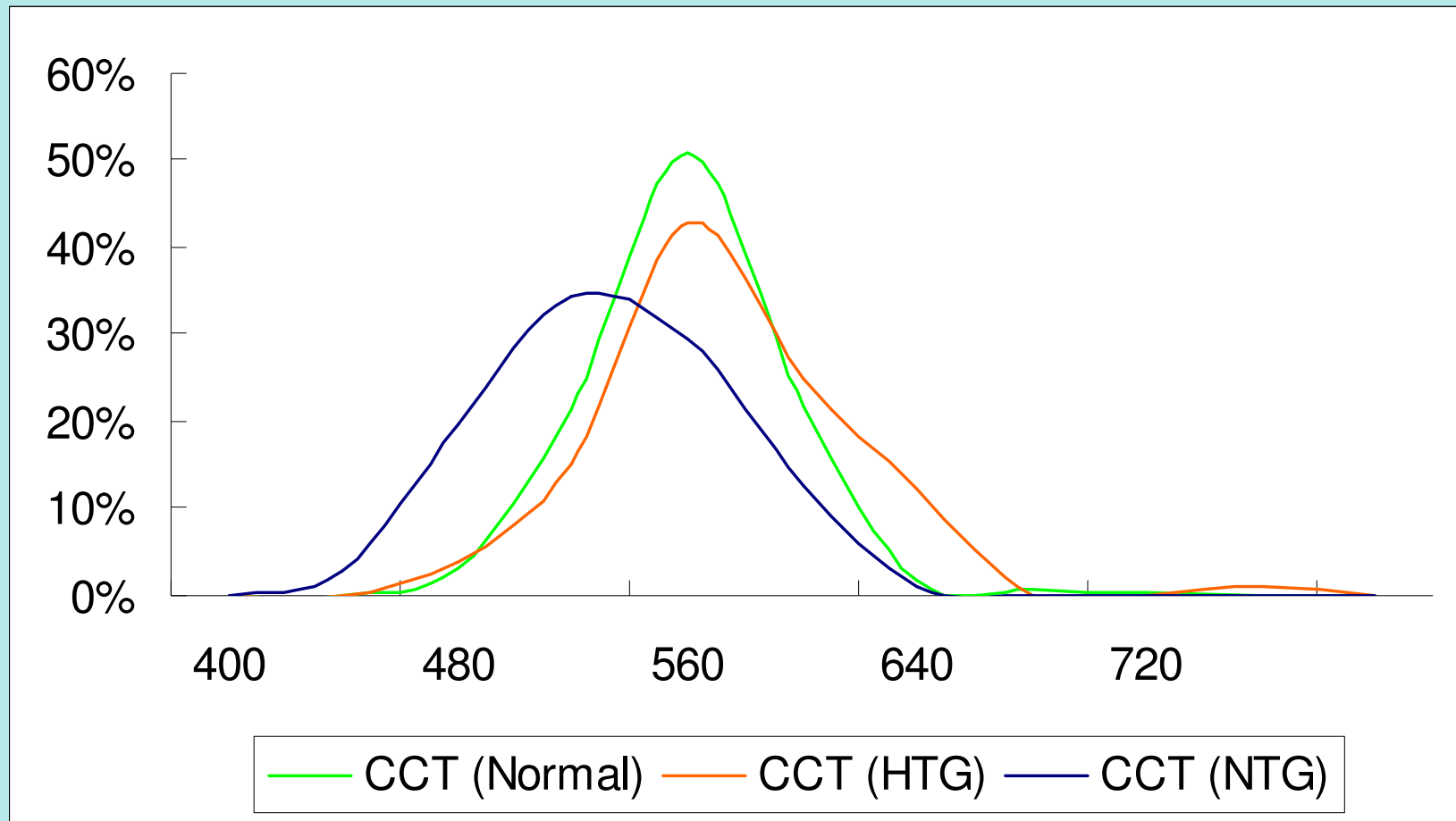
GAT (IOPg) and IOPcc in Normal Tension Glaucoma (NTG) Eyes



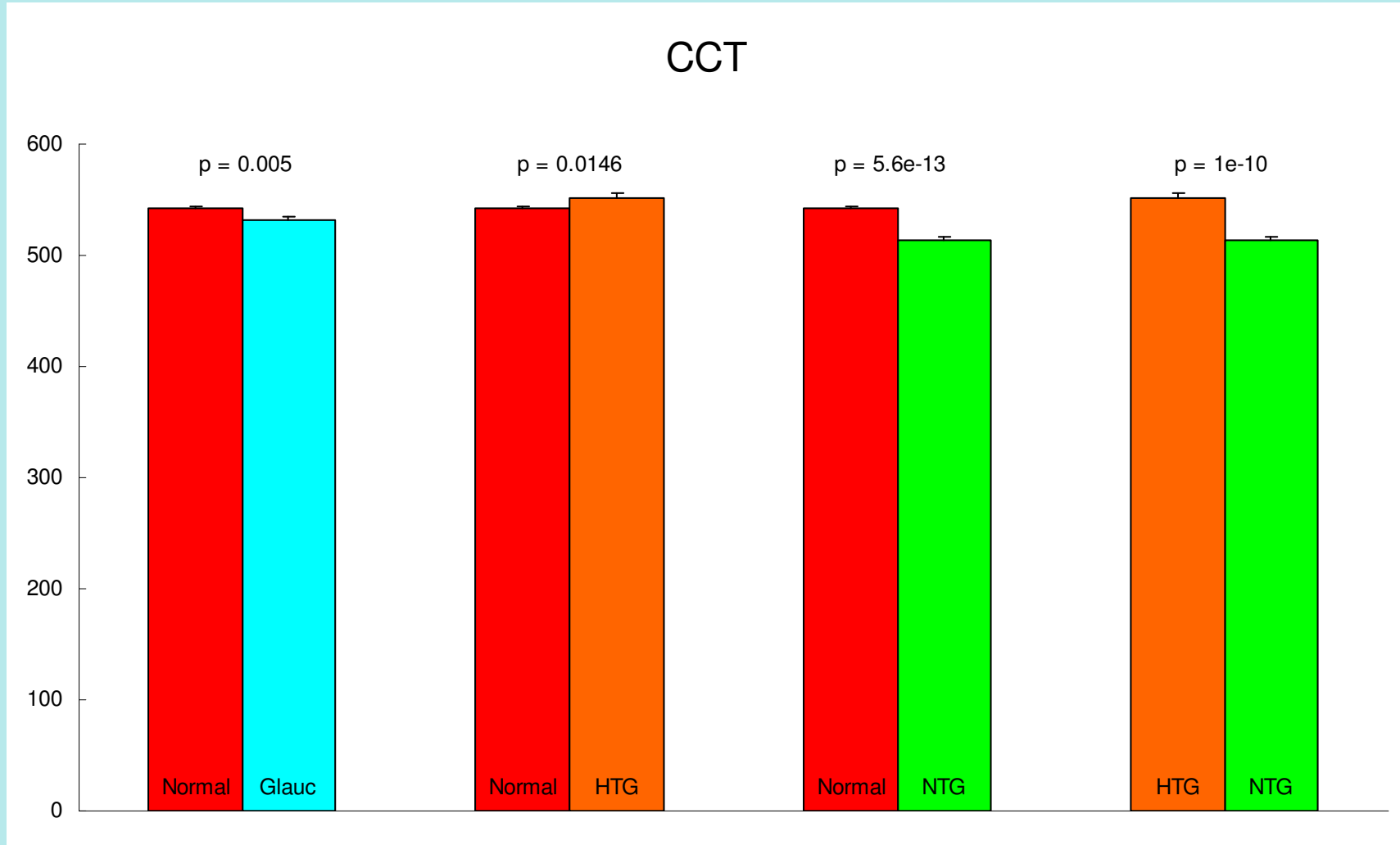
NTG eyes (GAT < 21)

- Thinner cornea (CCT: 513 ± 39)
- Lower elasticity (CH: 6.0 ± 1.1)
 - yields low GAT measurement (14.4 ± 3.4)
 - despite high IOP (IOPcc: 19.8 ± 3.4)
- **NTG (by GAT) eyes have higher IOPcc by 5.4 mmHg than GAT**
- **38% are reclassified “HTG” using IOPcc**

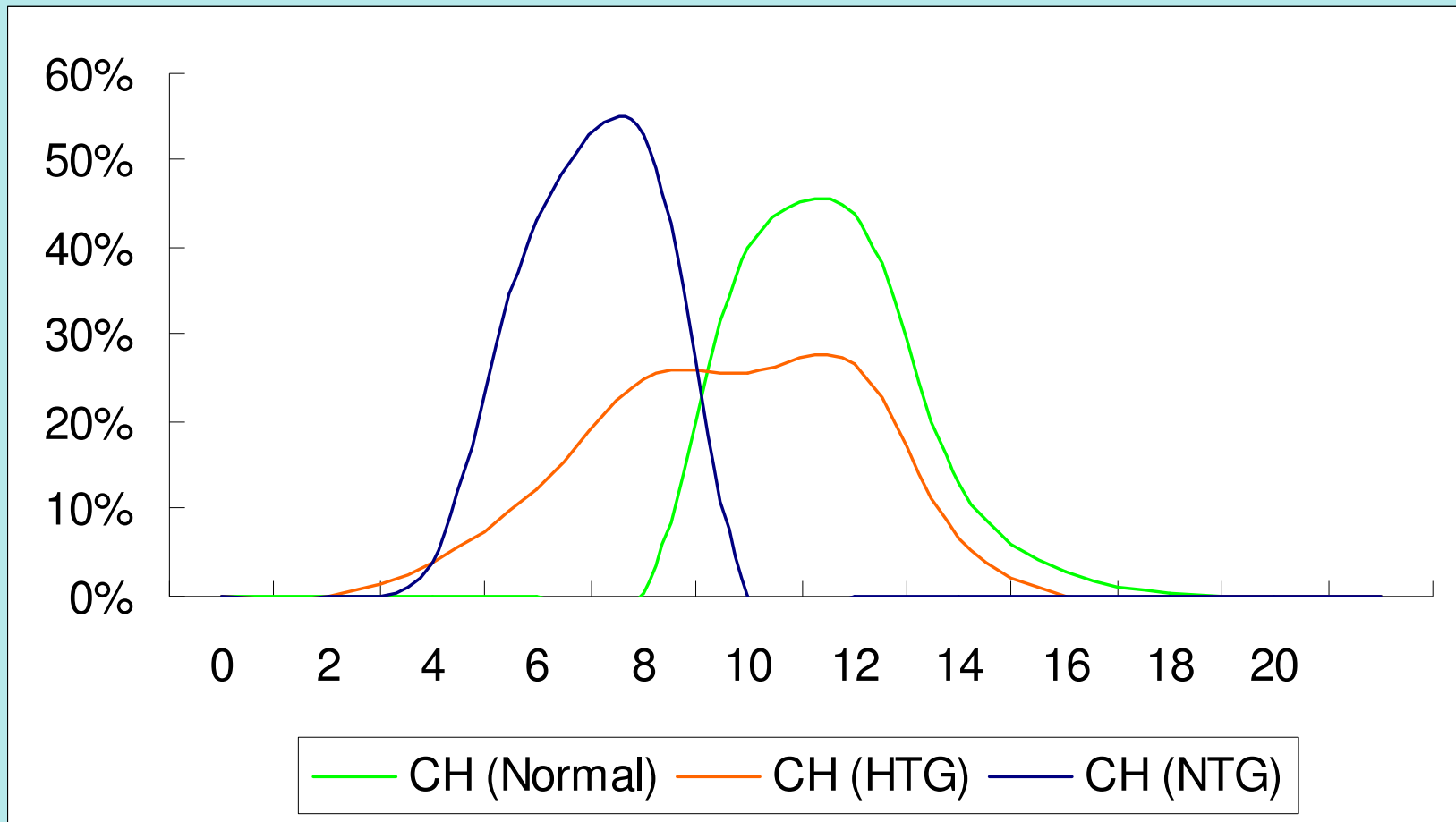
Frequency Distribution: CCT



Comparison of CCT



CH Distribution in Normal, NTG & HTG Eyes



Summary

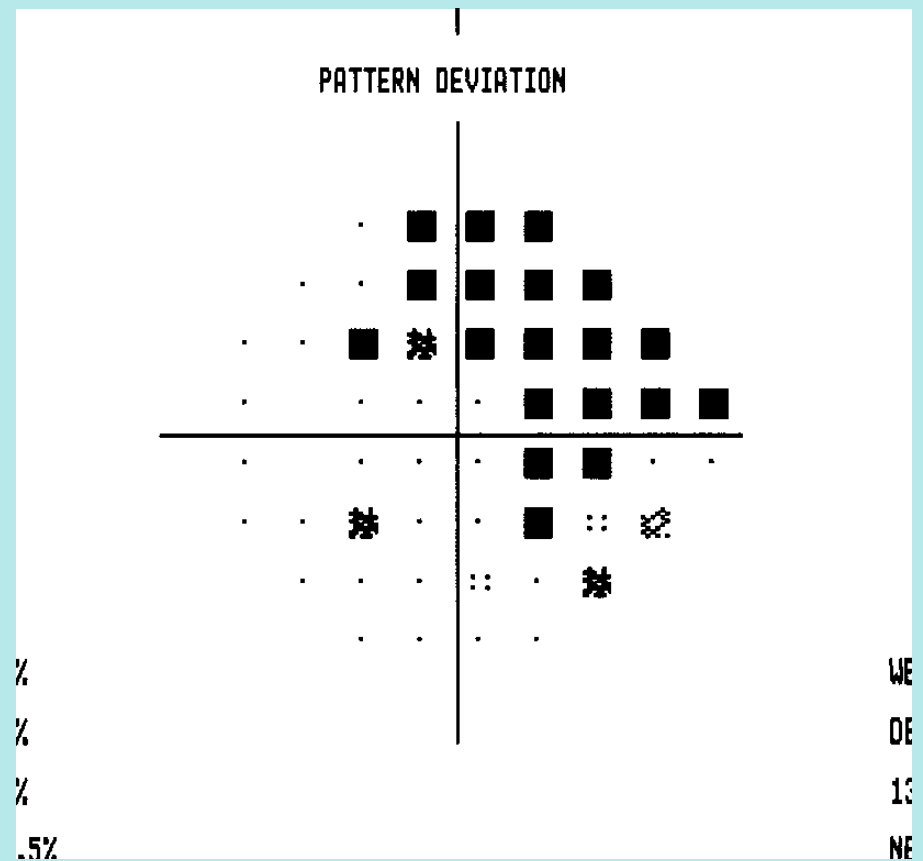
- **Threshold IOP 18 mmHg yields optimum specificity and sensitivity in diagnosing glaucoma by both GAT and IOPcc.**
- **IOPcc 18** performs better over GAT 18 in detecting glaucoma
- **Hysteresis** differences between NTG, HTG and normal eyes are more significant than **CCT** differences

Summary

- Measured by IOPcc18, majority of eyes considered to have NTG are **reclassified as HTG**
- If GAT is erroneous at diagnostic threshold, so may be the therapeutic endpoint (target). Therapeutic target IOP should better defined by IOPcc rather than GAT
- CCT is similar in normal and glaucoma eyes and is not diagnostic of glaucoma
- Glaucoma eyes as a whole have lower visco-elasticity (CH) of the cornea, which may be a marker of glaucoma

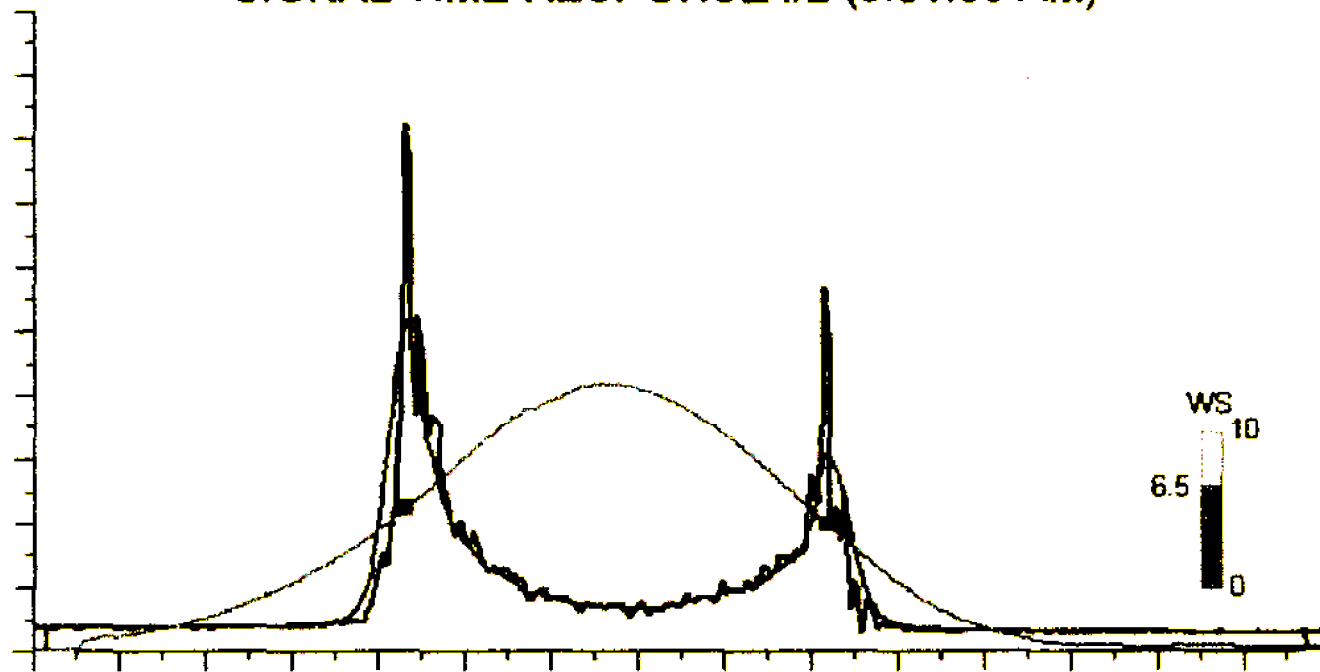
Case 1

- 83 yo white male with POAG on 3 topical agents
- VCDR: 0.9 OD, 0.85
- GAT: 22 mm Hg OU
- CCT 483/501



RIGHT EYE

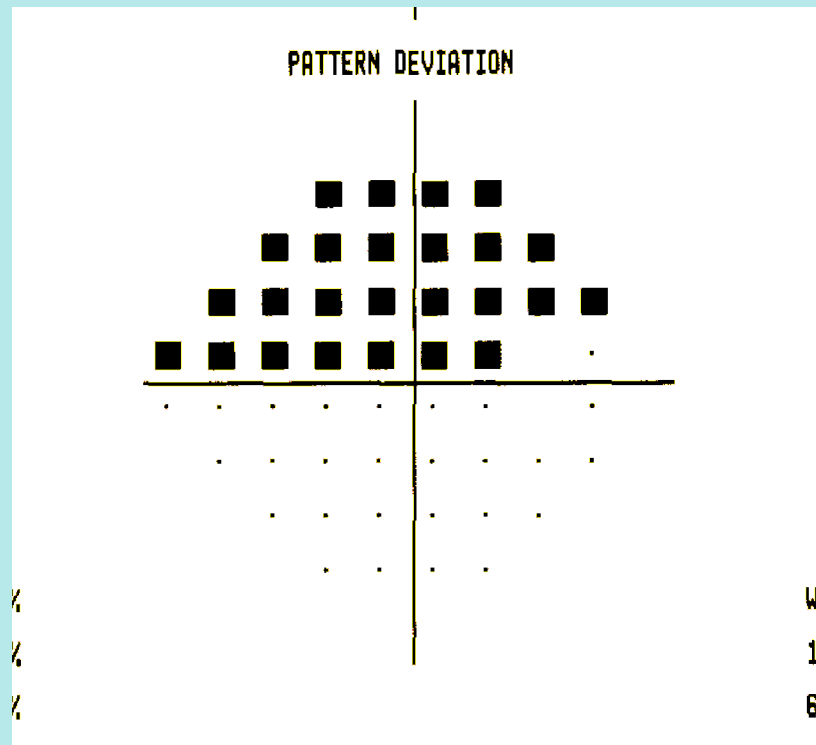
SIGNAL TIME RESPONSE #2 (9:31:00 AM)



IOPg : 21.3 IOPcc: 28.1 CCT : 0
CH : 3.9 CRF : 6.6 WS : 6.5 *

Case 2

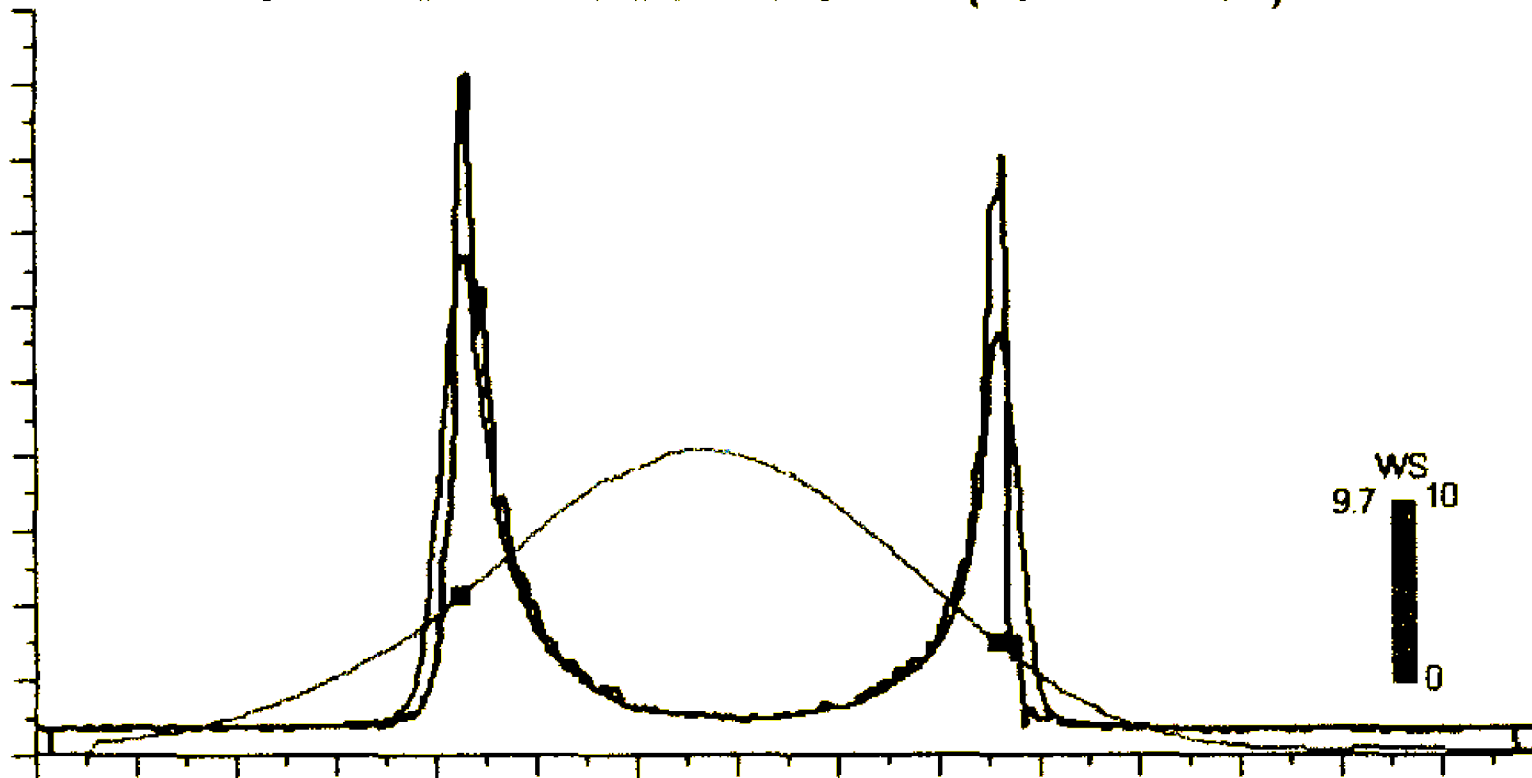
- 53 yo black male with POAG
 - Inferior notching OD > OS
 - GAT 15 mm Hg OU (travatan Z)
 - CCT 598/582



ORA Right Eye

RIGHT EYE

SIGNAL TIME RESPONSE #2 (10:31:44 AM)



IOPg : 16.9 IOPcc: 18.2 CCT: 0
CH : 9.5 CRF : 10.1 WS : 9.7 *