

Mechanisms of primary angle closure

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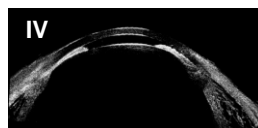
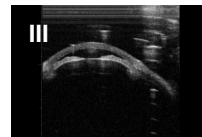
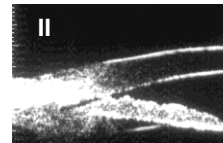
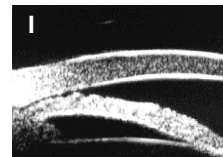
Moorfields Eye Hospital, London

WGA Angle closure consensus meeting 2006

Classification of mechanisms

4 - point scheme (Ritch)

- I. Pupil - block
- II. Ciliary body (Iris) induced
- III. Lens - induced
- IV. Causes behind the lens

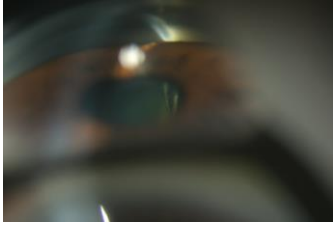


Identifies obstruction to aqueous flow at progressively more posterior levels

Ritch R et al. *The Glaucomas*. 1996:801

Images I, II & IV courtesy J. Liebmann and R. Ritch
Image III courtesy W. Nolan

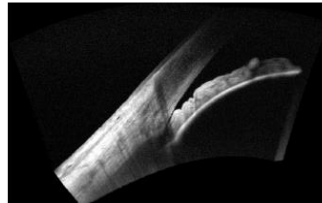
Pupil block



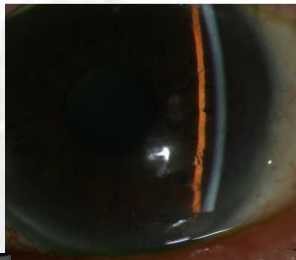
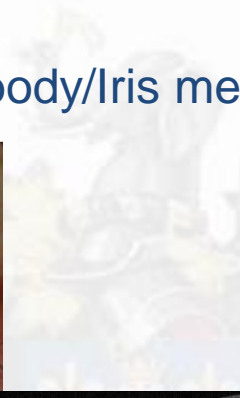
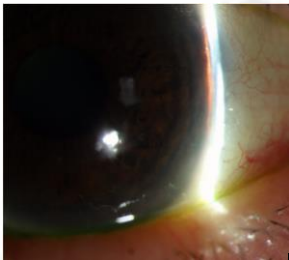
Steep iris curvature



High rise PAS

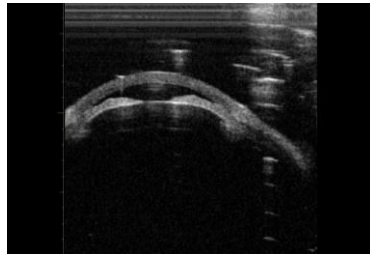
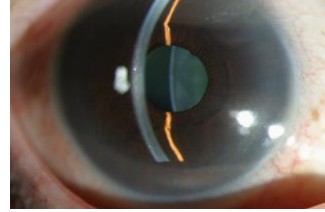
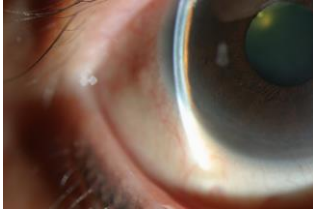


Ciliary body/Iris mechanism



Shallow peripheral and **deep** central anterior chamber

Lens mechanism



Shallow peripheral and **shallow** central ACD

Atypical - 42 yr old male

- Sudden onset reduction in distance vision
- RVA = 6/60, PH 6/9, LVA 6/36, PH 6/9
- N5 both eyes, 6/6 with -2.0D lens
- IOP R = 40mmHg, L = 34mmHg
- Gonioscopy – appositional closure both eyes

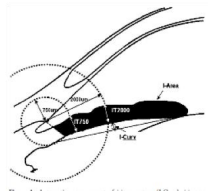
Choroidal effusions



Anatomical risk factors

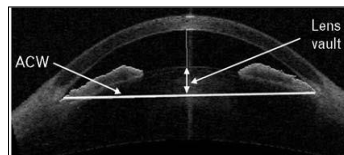
Old

- Shallow/ crowded AC
- Hyperopic eyes
- Large lens
- Lens position
- Lens curvature



New

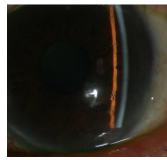
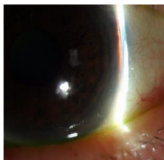
- Anterior chamber-width, area and volume
- Iris – thickness, area, and curvature.
- Lens – lens vault



Nongpiur ME, Ku JY, Aung T (2011b). Angle closure glaucoma: a mechanistic review. *Curr Opin Ophthalmol* 22(2): 96-101.

“Plateau Iris” configuration

- Deep Central AC
- Iris Profile: Flat
- Angular Iris Root
- Anterior Ciliary Body





Variants of plateau iris

Typical plateau iris

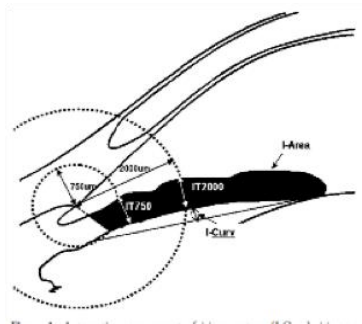
Thick peripheral iris

Prominent 'last iris roll'

M He, PJ Foster, GJ Johnson, PT Khaw EYE 2006

Quantitative Iris parameters

- I-Curv,- line from peripheral to the most central points of iris pigment epithelium
- I-Area - cross-sectional area of iris (from spur to pupil).
- Iris thickness (IT)750 and IT2000 - iris thickness measured at 750 and 2000 μm from the scleral spur, respectively.
- **Greater iris curvature, area and thickness**

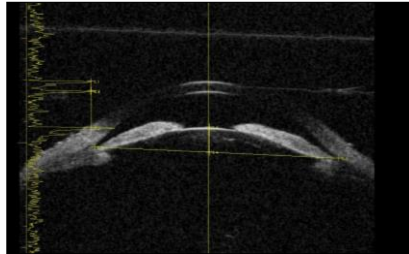


Automatic measurement of iris

Wang BS, Narayanaswamy A, Amerasinghe N, Zheng C, He M, Chan YH, et al. (2011). Increased iris thickness and association with primary angle closure glaucoma. Br J Ophthalmol 95(1): 46-50.

Lens vault

- \uparrow lens vault increases the risk AC by **48 times** compared to normal
- Bulk of lens located anterior to the plane of the angles plays an important role in the pathogenesis

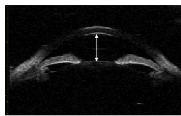


Absolute lens position (ALP), Relative Lens Position (RLP) defined by Lowe

- ✦ $ALP = ACD + LT/2$ (mm)
- ✦ $RLP = (ACD + LT / 2) / AL$ (no units)

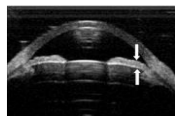
Nongpiur ME, He M, Amerasinghe N, Friedman DS, Tay WT, Baskaran M, et al. (2011a). Lens vault, thickness, and position in Chinese subjects with angle closure. Ophthalmology 118(3): 474-479.

Qualitative analysis



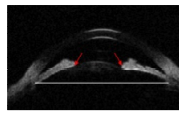
Anterior chamber depth

Distance between the anterior surface of the lens & cornea



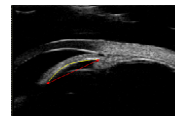
Iris thickness

Overall thickness and the thickness of the peripheral one third of the iris (termed basal iris thickness)



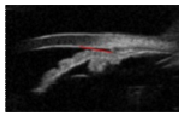
Iris profile

Deviation of the shape of the iris profile from a flat horizontal line



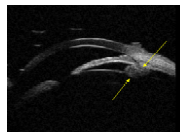
Iris convexity

Curvature of the posterior surface of the iris



Angulation of iris root

The iris root makes an about change in the point of insertion from the ciliary body.



Ciliary body size

The greatest distance Between the apex of the ciliary body and the base



Ciliary body position ranging from posterior (more neutral) to a more anterior position.

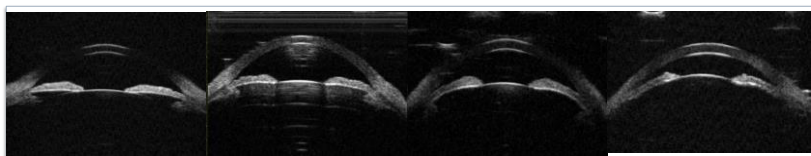
The absence of the ciliary sulcus indicates an anterior positioned CB. A present ciliary sulcus indicates a more posterior CB.

Developing a qualitative grading scale

- 11 observers
- Mixed experience - glaucoma consultants, clinical scientists, research fellow, technicians
- 2 images given as start and end anchor points
- Each observer asked to rank 8 images for each characteristic under standardised conditions
- Strength of correlation analysed for each observer against each other
- Kendall's W coefficient of concordance for multiple observers

R. Siddiqui, D. Henson, V. Sung, P. Good, R. Stanton, W. Nolan

Iris Profile



1

2

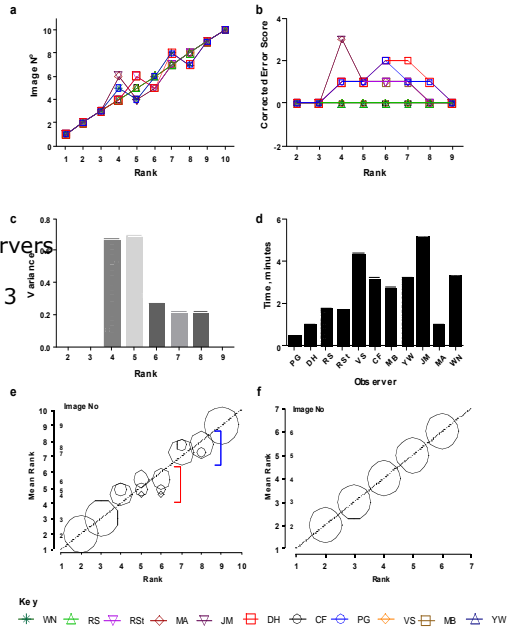
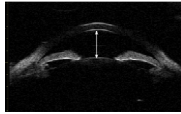
3

4

Extreme points – better agreement

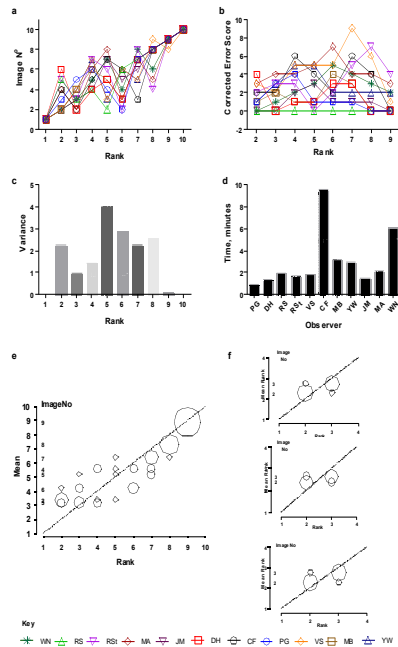
Anterior chamber depth

- Perfect concordance between 4 observers where $x=y$
- 2-point transpositions (7 and 8) and 3 point transposition(4,5,6)
- Highest variance at points 4,5 and 6



Ciliary body position

- Perfect inter-observer agreement could not be Reached
- Corrected error scores range from 0-36
- Variation in ranking images 2-8
- No simple 2, 3 or 4-point transpositions
- Images 2,4,5,7 and 8 (highest error scores) pruned



Pruned scales concordance

Characteristic	Number of points in scale	Pruned Kendall's Concordance	10 Kendall's Concordance (W)
ACD	7	1.00	0.95
Iris Thickness	5	0.92	0.91
Iris Profile	5	1- 0.84	0.84
Convexity	5	0.85	0.79
Angulation	4	0.41 - 0.21	0.41
Ciliary Body Size	5	0.92 - 0.80	0.90
Ciliary Body Position	4	-1 - 1	0.65

Mechanisms of angle closure
- Do they matter?

Subclassification of Primary Angle Closure Using Anterior Segment Optical Coherence Tomography and Ultrasound Biomicroscopic Parameters

Junki Kwon, MD,¹ Kyung Rim Sung, MD, PhD,² Seungdong Han, PhD,² Ye Ji Moon, MD,¹ Joong Won Shin, MD¹

Ophthalmology 2017;124:1039-1047

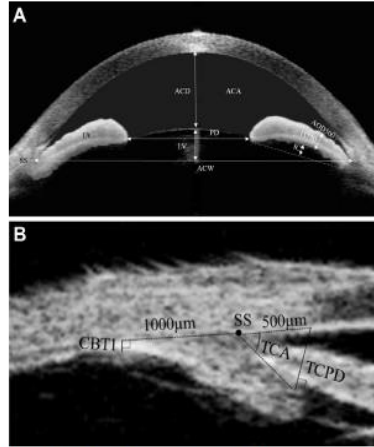


Figure 1. Quantitative parameters measured on the (A) anterior-segment optical coherence tomography (AS-OCT) and (B) ultrasound biomicroscopic images. ACA = anterior chamber area; ACD = anterior chamber depth; ACW = anterior chamber width; AOD500 = angle opening distance 500 μm from the scleral spur; CB = ciliary body; IA = iris cross-sectional area; IC = iris curvature; IT750 = iris thickness 750 μm from the SS; LV = lens vault; PD = pupil diameter; SS = scleral spur; TCA = trabecular-ciliary process angle; TCPD = trabecular-ciliary process distance.

Table 2. Comparison of Anterior Segment Optical Coherence Tomography and Ultrasound Biomicroscopy Parameters Used in Cluster Analysis (N = 73)

Variables	Cluster A (n=48)	Cluster B (n=25)
AS-OCT parameters		
AOD500 (mm)	0.15±0.10	0.17±0.08
LV (mm)	1.11±0.35	1.22±0.24
ACD (mm)	2.0±0.3	2.0±0.2
ACA (mm ²)	14.4±2.6	14.1±2.1
ACW (mm)	11.8±0.5	11.9±0.4
IC (mm)	0.16±0.08	0.11±0.04
IA (mm ²)	4.29±1.04	4.04±0.90
IT750 (mm)	0.43±0.10	0.43±0.08
PD (mm)	3.4±0.8	3.4±0.8
UBM parameters		
TCA (degrees)	91.0±13.4	63.7±6.2
TCPD (mm)	0.99±0.22	0.78±0.16
CBT1 (mm)	0.45±0.11	0.44±0.09
CB orientation (neutral/anterior), temporal	35/13	0/25
CB orientation (neutral/anterior), nasal	35/13	0/25
Iris insertion (basal/middle/apical), temporal	37/9/2	12/11/2
Iris insertion (basal/middle/apical), nasal	36/10/2	14/9/2
Iris angulation (none/mild/pronounced), temporal	35/13/0	5/14/6
Iris angulation (none/mild/pronounced), nasal	36/12/0	5/14/6
Iris convexity (absent/mild/moderate/extreme), temporal	23/24/1	22/3/0
Iris convexity (absent/mild/moderate/extreme), nasal	24/23/1	20/5/0
Ciliary sulcus (absence/presence), temporal	9/39	24/1
Ciliary sulcus (absence/presence), nasal	3/45	24/1
Irido-angle contact (closure/open), temporal	18/30	20/5
Irido-angle contact (closure/open), nasal	17/31	20/5

PAC/ PACG post iridotomy imaging

TCA = Trabecular-ciliary process angle

TCPD = Trabecular-ciliary process distance

Table 3. Comparison of Other Clinical Characteristics between 2 Clusters Determined by Anterior Segment Optical Coherence Tomography and Ultrasound Biomicroscopy (N = 73)

Variables	Cluster A (n = 48)	Cluster B (n = 25)	P Value
Age (yrs)	65.1±7.1	66.0±8.4	0.449
Sex (men/women)	9/39	4/21	1.000
AXL (mm)	22.5±0.4	22.8±0.6	0.360
PAS (No/<2Q/>2Q)	35/12/1	20/5/0	0.668
Pre-LPI IOP (mmHg)	18.8±5.4	16.2±4.5	0.037
Post-LPI IOP (mmHg)	13.9±2.5	14.1±2.1	0.647
IOP difference (mmHg)*	5.0±5.0	2.0±4.2	0.014
IOP reduction (%) [†]	22.3±17.9	8.3±19.5	0.003
No. of antiglucoma medication	1.0±1.2	1.0±1.0	0.360

AXL = axial length; IOP = intraocular pressure; LPI = laser peripheral iridotomy; PAS = peripheral anterior synechia; Q = quadrant.
 *Pre-LPI IOP – post-LPI IOP (mmHg).
[†]IOP difference/pre-LPI IOP × 100 (%).
 P values with statistical significance (<0.05) appear in boldface.

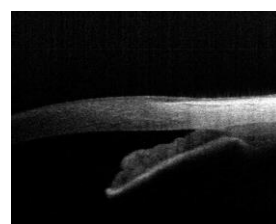
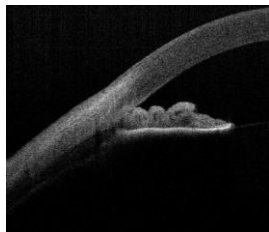
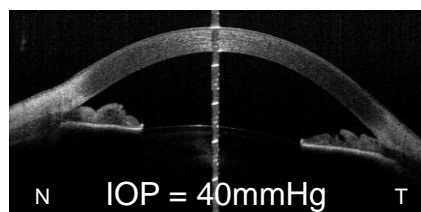
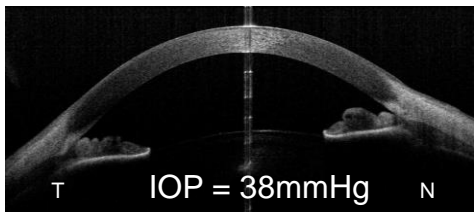
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Clinical case:

45yr old, symptomatic closure and ↑IOP, post - iridotomy

Right Eye

Left eye

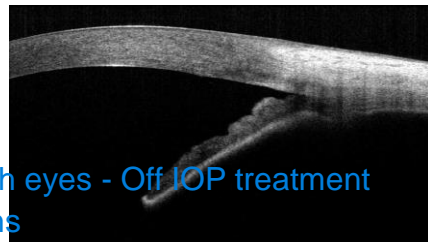
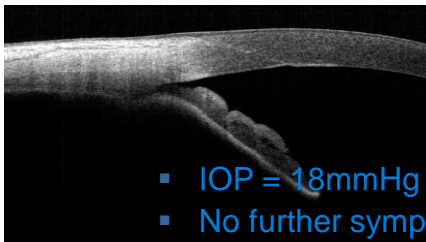
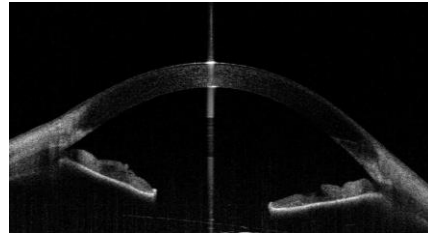
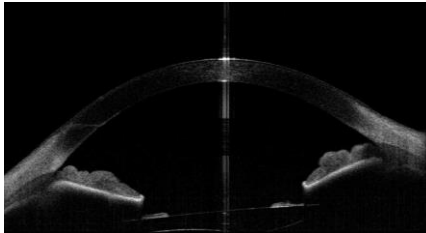


Good response to Pilocarpine

Clear lens extraction both eyes

OD

OS



- IOP = 18mmHg both eyes - Off IOP treatment
- No further symptoms

Summary

- Pupil block, iris/ ciliary body and lens mechanisms
- Combination of all three often present
- Quantitative analysis using imaging can help classify by mechanism
- Qualitative analysis better for linear measures
- Determining mechanism can help predicting response to treatment but most cases with raised IOP respond to lens extraction

Thank you