Anterior Chamber Angle: Assessment and Anomalies

Dave Hicks, OD, FAAO
GWCO
Portland, OR
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Introduction

- Native Oregonian and Willamette Bearcat
- UC Berkeley School of Optometry 2008
- San Francisco VA Residency 2009
- VA Staff Optometrist – teaching
- Regular lecturer at AAO and other meetings
- No conflicts of interest

Goals

- Review anatomy of the anterior chamber angle
- Review gonioscopy and other imaging techniques for evaluating the angle and anterior chamber
- Discuss abnormal angle and anterior chamber findings and management

Angle Anatomy Overview

- Iris
- Ciliary body (CB)
- Scleral spur (SS)
- Trabecular meshwork (TM)
  - Pigmented and non-pigmented
- Schwalbe’s Line (SL)
  - Sampaolesi’s line when pigmented
Iris Processes

- Usually end at SS, but can go to SL

Iris processes
- Fine extensions toward TM or SL
- Usually still allow a view of the angle
- Differentiate from peripheral ant. synechiae (PAS)

Greater circle of iris (MAC)
- Anterior ciliary and long posterior ciliary arteries
- Both normal, but could mimic NV

Angle Anatomy Overview

- Iris processes
  - Fine extensions toward TM or SL
  - Usually still allow a view of the angle
  - Differentiate from peripheral ant. synechiae (PAS)

Angle Neovascularization (NVA)
- Differentiate from normal iris vessels
- Causes – DM, CRVO, OIS, tumor, etc.
- Significance
- Evaluation – gonio
- Management – depends on etiology
**Angle Function**

- Maintain IOP

- Aqueous outflow pathways
  - Conventional: TM → Schlemm’s canal → intrascleral channels → episcleral veins
  - Unconventional (uveoscleral): ciliary muscle fiber spaces → supraciliary and suprachoroidal space → scleral emissary canals

**Van Herick Estimation (1969)**

<table>
<thead>
<tr>
<th>Angle Grade</th>
<th>Limbal AC Depth vs. Corneal Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Slit</td>
</tr>
<tr>
<td>1</td>
<td>&lt;1/4</td>
</tr>
<tr>
<td>2</td>
<td>1/4</td>
</tr>
<tr>
<td>3</td>
<td>1/4 to 1/2</td>
</tr>
<tr>
<td>4</td>
<td>1 or more</td>
</tr>
</tbody>
</table>

**Gonioscopy**

- Gold standard

- Technique
  - Lighting: dark room, smallest possible beam height/width
  - Try to avoid miosis

- Innate variability, prone to error

- Indentation gonioscopy
  - Appositional vs. synechial closure

**Angle Grading Systems**

- Sheie: no longer used

- Shaffer: grades 0-4, widest is 4

- Modified Shaffer: angle structures named

- Spaeth

**Shaffer System**

- Grade 4 = CB
- Grade 3 = SS
- Grade 2 = TM
- Grade 1 = SL
- Grade 0 = No structures (NS)

**Spaeth System**

- Step 1: Site of iris insertion
  - A = Anterior to TM (i.e. SL)
  - B = Behind SL (i.e. at TM)
  - C = Centered at SS
  - D = Deep to SS (i.e. anterior CB)
  - E = Extremely deep in CB

- Step 2: Angle width
  - 10 degree increments
Spaeth System

- **Step 3:** Configuration of peripheral iris
  - **Original**
    - s = steep/convex
    - r = regular or flat
    - q = quixotic/queer or deeply concave
  - **New**
    - b = bows 1 to 4+
    - p = plateau
    - f = flat
    - c = concave

- **Step 4:** TM pigmentation
  - Grade 1-4

**Normal Open Angle**

**Anomalous Angle Findings**

- **Common pigment**
  - Age-related
  - Pigment dispersion syndrome
  - Pseudoexfoliation

- **Concerning pigment**
  - Uveal or ring melanoma

Melanoma Features

- Unilateral
- Pigmented aqueous cells
- Iris displacement and heterochromia
- Subluxed lens
- Sectoral cataract
- Shallow AC or closure
- NVI
- Variable IOP, usually elevated
- Dark angle pigment
- Prominent episcleral vessels

Lee, et al. OJO, 1996; 83: 184-188.

**TABLE 2** Uveal Melanoma Distribution

<table>
<thead>
<tr>
<th>Study</th>
<th>irido melanoma</th>
<th>Ciliary body melanoma</th>
<th>Iris and ciliary body melanoma</th>
<th>Choroidal melanoma</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yacoft, 1976</td>
<td>9/125</td>
<td>6/125</td>
<td>6/125</td>
<td>6/125</td>
<td>66/125 (6.33%)</td>
</tr>
<tr>
<td>Shields et al., 1997</td>
<td>102/1111</td>
<td>4/1111</td>
<td>95/1111</td>
<td>6/1111</td>
<td>191/1111 (90.52%)</td>
</tr>
</tbody>
</table>

66 eyes from an ophthalmic pathology department
2704 eyes with intracranial tumors from a neural oncology department
2211 eyes with uveal melanoma

- Choroidal: 69-90%
- Iris/CB: 4-8%
Melanoma

Anomalous Angle/AC Findings

- Deep angles
  - Iris to TM angle 20-45 degrees
  - PDS

- Angle recession
  - Can be sectoral or circumferential
  - Trauma

Angles At Risk

- Iris to TM angle <20 degrees
  - 2-6% of Caucasians

- Irido-trabecular contact preferred term over “narrow” or “occludable”
  - 180° vs. 270°

- ACA deemed closed if iris touches cornea anterior to SS
Primary Angle Closure (PAC)

- PAC suspect
  - >270° of irido-trabecular contact
  - Shaffer grade 2 or less
  - No PAS
  - Normal IOP, optic nerve, and VF

- PAC
  - >270° of irido-trabecular contact
  - Either elevated IOP or PAS
  - Normal optic nerve and VF

- PAC glaucoma (PACG)
  - >270° of irido-trabecular contact
  - Elevated IOP
  - Optic nerve and VF damage

Closure impossible
- Angle closed

Closure possible
- Angle open

Closure probable
- Angle partially open


Safe Dilation

- Shaffer grade 3 or 4
- Less than 180° of irido-TM contact
- Risk of angle closure with dilation
  - Rotterdam: ~1 in 3,380 (Caucasians)
  - Others: ~1 in 20,000 with both trop/phenyl
  - Minimal to no risk with just tropicamide

- High resolution ultrasound
- Non-invasive, two-dimensional
- Quantitative and qualitative
- Not as deep as B-scan
- Takes training – eye cup, water bath


Deep (a) Ultrasound biomicroscopy of a ciliary body tumor extending up to the pars plana. C: Cornea, S: Sclera, CB: Ciliary body. (b) Peripheral anterior synechiae on gonioscopy in the same patient.

Masslin, et al. IJO, 2015 Aug; 63(8);630-640.

PAS in same pt

UBM of CB tumor


UBM terminology

- ARA – angle recess area
- TIA – trabecular iris angle
- AOD 250/500 – angle opening distance
- TCPD – trabecular-ciliary process distance
- ICA – iridociliary angle
- ID1 to ID3 – iris thickness measurements
- ICPD – iris-ciliary process distance
- ILCD – iris-lens contact distance
- IZD – Iris zonular distance


Widening of ACA in PAC, not in PACG (Dada)
28% of PACS convert to PAC after LPI (Ramani)


Plateau Iris

Posterior iris turns sharply to insertion
Iris inserts to anterior CB
Flat or concave iris, deep central AC

Plateau Iris
- Plateau Iris Configuration
- Plateau Iris Syndrome – post LPI
- Compression gonio
  - “double hump” sign
- Treatments
  - LPI
  - ALPI
  - Cataract surgery

UBM of ALPI

Plateau Iris Configuration

Compression gonio

“double hump” sign

Treatments

LPI

ALPI

Cataract surgery

Initial

After Laser Irido-plasty


AS-OCT Basics

- Time domain at 1310nm
  - Single scan of entire AC
- Fourier domain at 830nm
  - Can see SS, SL, etc
- Swept source at 1310nm
  - 3D angle analysis
- May identify more PAC than gonio

AS-OCT Terminology

- SL-angle opening distance (SL-AOD)
- AOD 500/750
- SL-trabecular iris space area (SL-TISA)
- ACV – Anterior chamber volume
- ACD – Anterior chamber depth
- ACA – Anterior chamber area
- ACW – Anterior chamber width
- Iris thickness at 750um
- LV – Lens vault

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LV – Lens vault
Need to identify angle structures

Appositional Angle Closure

AS-OCT vs. UBM
- Non-contact
- Minimal training
- Better resolution
- Faster
- Wider FOV
- Upright
- Limited ability to visualize structures posterior to iris

Contact, coupling
- Skilled operator
- Lower resolution
- Slower
- Shorter FOV
- Supine or upright
- Can visualize posterior to iris

Comparing Gonioscopy With Visante and Cirrus Optical Coherence Tomography for Anterior Chamber Angle Assessment in Glaucoma Patients
- 1 eye of 50 pts
- 60% women
- 64% Caucasian
- All phakic
- POAG, ACG, OHTN, or PXG

Visante and Cirrus OCT may have limited ability to identify angle closure because of difficulty identifying angle structures
Lack of visibility more superior and inferior

- Iris to TM angle <20 degrees
- Still at risk

None of these imaging methods provides sufficient information about the ACA anatomy to be considered a substitute for gonioscopy.

Ophthalmic Technology Assessment

Evaluation of the Anterior Chamber Angle in Glaucoma
A Report by the American Academy of Ophthalmology

- Literature review for PAC
- UBM, AS-OCT, Scheimpflug, SPAC

Anomalous Angle and AC Findings
- Iridodialysis
- Retained lens fragments after CE
- Anterior chamber intraocular lenses
- Hyphema/microhyphema
Iridodialysis

- Traumatic, iatrogenic, or congenital
- Can be asymptomatic
- Glare, diplopia, photophobia
- IOP issues
  - TM damage, PAS, CB damage
- Need to rule out melanoma

Retained Lens Fragments

- Almost always in inferior angle
- Can require gonio to visualize
- Cortical vs. nuclear
- Time to diagnosis is highly variable
- Corneal edema, uveitis, IOP, glaucoma
- Treatment – corticosteroids, IOP lowering meds, surgery

Retained Nuclear Fragments in the Anterior Chamber after Phacoemulsification with an Intact Posterior Capsule

- 16 eyes at Bascom Palmer, retrospective
- Time to discovery: 1-182 days, average 38
- 37.5% of fragments were not visible by SLE
- Cortical – resorption can occur
- Nuclear – more corneal edema
- Both have AC reaction and need steroids
- Surgical removal may be required
Clinical Features and Outcomes of Retained Lens Fragments in the Anterior Chamber After Phacoemulsification

ZACHARY L. ZAVODNI, JAY L. MEYER, AND TERRY KIM

- 54 eyes at Duke
- Time to discovery: 1 day to 6+ months
- 87% of fragments were diagnosed by SLE
- 56% of eyes had corneal edema
  - Inferior edema should be a clue
- Surgical removal recommended in all cases


ACIOLs

- Safety for dilation
  - Iris fixation
  - Surgical iridectomy vs laser iridotomy
  - Pupil clearance, lens capture

- Uveitis

Microhyphema

- Significance
- Causes – trauma, surgery, PXF
- Evaluation – photos, gonio, iris FA
- Management – depends on etiology

Conclusions

- The angle and anterior chamber are vital but often overlooked structures
- Knowledge of angle anatomy and various examination techniques are important to make proper diagnoses
- Management and timely referral when complications develop is crucial
Thank you!

Questions?
davehicks.od@gmail.com

References available upon request