Anterior Chamber Angle: Assessment and Anomalies

Dave Hicks, OD, FAAO

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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
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)

- Greater circle of iris (MAC)
  - Anterior ciliary and long posterior ciliary arteries

- Both normal, but could mimic NV
Iris Processes

- Usually end at SS, but can go to SL

Major arterial circle of iris

Angle Vessels

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

### Spaeth System

<table>
<thead>
<tr>
<th>SITE of ANGLE INSERTION</th>
<th>ANGLE WIDTH (Shaffer)</th>
<th>PERIPHERAL IRIS CONFIGURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>E40c, 4+TMP – very deep</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A10b – very narrow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D40f, 2+ TMP – normal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Normal Open Angle
Anomalous Angle Findings

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

- Concerning pigment
  - Uveal or ring melanoma
Fig. 7-A8  (A) The angle in pseudoexfoliation. Note the clumped brown pigment over the pigmented trabecular meshwork. There is also a line of pigment along Schwalbe’s line and another wavy line of pigment anterior to this line. (B) Pseudoexfoliation with a dense pigmentation of the angle that obscures most angle structures. The corneal wedge identifies Schwalbe’s line.

Fig. 7-A9  Patient with the pigment dispersion syndrome. The angle demonstrates a dense band of black pigment in the posterior trabecular meshwork.
(From Atwood WLM: Color atlas of gonioscopy, San Francisco, Foundation of American Academy of Ophthalmology, 2000.)
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

### TABLE 2 Uveal Melanoma Distribution

<table>
<thead>
<tr>
<th>Study</th>
<th>Iris melanoma</th>
<th>Ciliary body melanoma</th>
<th>Iris and ciliary body melanoma</th>
<th>Choroidal melanoma</th>
<th>Choroidal and ciliary body melanoma</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yanoff, 1970</td>
<td>8/96</td>
<td>6/96</td>
<td>8/96</td>
<td>66/96</td>
<td>8/96</td>
<td>96 eyes from an ophthalmic pathology department</td>
</tr>
<tr>
<td></td>
<td>8.33%</td>
<td>6.25%</td>
<td>8.33%</td>
<td>68.75%</td>
<td>8.33%</td>
<td></td>
</tr>
<tr>
<td>Shields et al, 1987</td>
<td>102/2111</td>
<td>96/2111</td>
<td>1913/2111</td>
<td>90.62%</td>
<td></td>
<td>2704 eyes with intraocular tumors from an ocular oncology department (2111 eyes with uveal melanoma)</td>
</tr>
<tr>
<td></td>
<td>4.83%</td>
<td>4.54%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **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

Primary Angle Closure (PAC)

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

Closure impossible

Closure possible

Closure probable

Angle closed

(A) Wide open angle – Grade 3-4

(B) Moderately narrow angle – Grade 2

(C) Extremely narrow angle – Grade 1

(D) Angle closure – Grade 0

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

Ultrasound Biomicroscopy in Glaucoma

Tanuj Dada, MD,1 Ritu Gadia, MD,2 Ajay Sharma, BSc,1 Parul Ichhpujani, MD,3 Shveta Jindal Bali, MD,1 Shibal Bhartiya, MD,1 and Anita Panda, MD, FICS, FAMS, MRCOphth1

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

(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.

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

UBM of LPI

- 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

Anterior Segment OCT


Angmo, et al. OJO. 2016 Jan-Apr; 9(1);3-10.
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
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

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

- Lack of visibility more superior and inferior

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

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

Jennifer I. Hui, MD, Jane Fishler, BS, Carol L. Karp, MD, Magdalena F. Shuler, MD, PhD, Steven J. Gedde, MD

- 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 J. ZAVODNI, JAY J. 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 at aaopt.org