Glaucoma Phenotypes in Humans

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Overview of Human Glaucoma

I. Anatomy of the Anterior Chamber

II. Open-angle Glaucoma
   A. Primary (POAG)
   B. Secondary – selected varieties

III. Angle-closure Glaucoma
   A. Primary/acute
   B. Variants
Anatomy of the Anterior Chamber
Aqueous Humor Dynamics

- A Patient’s Guide to Glaucoma www.medrounds.org
Aqueous Humor Dynamics

- A Patient’s Guide to Glaucoma www.medrounds.org
Schlemm’s Canal and Venous Plexus

- Aqueous humor travels through trabecular meshwork (within anterior chamber) → Schlemm’s canal → venous plexus

- Continuous, circumferential Schlemm’s canal around limbus

Gonioscopy to View the Anterior Chamber Angle
Anterior Chamber Angle Anatomy

- Iris
- Ciliary Body Band
- Scleral Spur
- Trabecular Meshwork
- Schwalbe’s Line
  - Termination of Descemet’s membrane, aka. *Sampaolesi line* when pigmented

Pigmented Schwalbe’s line (Sampaolesi line)

www.gonioscopy.org
Anterior Chamber Angle Anatomy

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I Can See The Line!
Anterior Chamber Angle Anatomy

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I Can See The Line!
I Can’t See The Line!
Anterior Chamber Depth Classification

Gonioscopic grading of chamber angle

- **Schwalbe line**
- **Trabecular meshwork**
- **Scleral spur**
- **Ciliary band**

**Grade III**
- Wide open angle. All angle structures visible
  - 45° - 50°

**Grade II**
- Open angle. Most angle structures visible
  - 30° - 40°

**Grade I**
- Very narrow angle. Few angle structures visible
  - 10°

**Grade 0**
- Closed angle. No angle structures visible

Gonioscopy allows direct observation of chamber angle and evaluation of angle occlusion.
# Anterior Chamber Depth Classification

![Eye Image]

## Table 2. Van Herick system of angle estimation.

<table>
<thead>
<tr>
<th>Grade of angle</th>
<th>Depth of peripheral chamber</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>≥ corneal thickness</td>
</tr>
<tr>
<td>3</td>
<td>1/4 to 1/2 corneal thickness</td>
</tr>
<tr>
<td>2</td>
<td>1/4 corneal thickness</td>
</tr>
<tr>
<td>1</td>
<td>&lt; 1/4 corneal thickness</td>
</tr>
<tr>
<td>Slit</td>
<td>Dangerously narrow</td>
</tr>
</tbody>
</table>
Anatomy of the Anterior Chamber

- Angle configuration can vary widely, especially in terms of providing access of the aqueous humor to the trabecular meshwork.

- Gonioscopy is the standard of care for evaluating angle configuration.

- Various classification systems exist, but we can generalize angle structures as being open or closed.
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Open-Angle Glaucoma
Selected* Human Glaucoma Syndromes

• Open Angle Glaucoma
  – Primary Open Angle Glaucoma
  – Low-tension Glaucoma
  – Angle Recession/Traumatic Glaucoma
  – Pigment-dispersion (Pigmentary) Glaucoma

*Selected by Dr Dick Dubielzig
Primary Open Angle Glaucoma

- Prevalence in US
  - 2011:
    - 2.71 Million total
    - Age: 70-79 (31% of total POAG pts are in this age group)
  - Predicted as of 2050:
    - 7.32 Million total
    - Age: 70-79 (32%)

Primary Open Angle Glaucoma

- Clinical Course
  - Gradual loss of retinal ganglion cells over many years
  - No buphthalmos, corneal edema, redness or pain
  - “Silent thief of sight”
Primary Open Angle Glaucoma

• **Pathophysiology**
  – Characteristic pattern of retinal ganglion cell loss over time
  – Gradual loss of trabecular meshwork cells
    • Poor maintenance of trabecular pores
    • Fewer giant vacuoles pulling aqueous from anterior chamber into Schlemm’s Canal

- Image: Optic nerve head cupping progression
- Graph: 0.3 c/d, 0.6 c/d, 0.95 c/d
Low-Tension Glaucoma

• Aka. “Normal-tension” Glaucoma

• Apparent progression of glaucomatous optic nerve damage while intraocular pressure is within normal range, corrected for corneal thickness

• Diagnosis of exclusion
  – Usually in pts older than 60 years
  – Neuro-ophthalmology workup for vascular and compressive etiologies
  – Still target IOP reduction of 30%
Angle Recession Glaucoma

• Blunt force trauma

• Corneal compression causes force wave into iris/lens diaphragm

• Weak junction: circumferential/radial layers of ciliary body muscle

• Tears are permanent, direct coincidental trauma to meshwork and atrophy/collapse of meshwork pillars → decreased outflow
Pigmentary Dispersion Glaucoma

- **Demographics**
  - Myopic, young adult males

- **Mechanism**
  - Mechanical friction between iris and lens releases pigment granules into aqueous
  - Granules deposit in trabecular meshwork, blocking movement of giant vacuoles from anterior chamber to Schlemm’s canal
Pigment Dispersion Glaucoma

- Other clinical signs
  - Krukenberg spindle (cornea)
  - Scheie stripe/Zenkmayer line (lens)
Pigment Dispersion Glaucoma

Collapse of meshwork beams due to pigment overload

Pigment granules in trabeculocytes
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** Pathologic samples limited because it is uncommon to remove the eye in human glaucoma
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Angle-Closure Glaucoma
Narrow/Occludable Angle
Narrow/Occludable Angle

- Dynamic gonioscopy
  - Assessment to determine presence of peripheral anterior synechiae
Selected* Human Glaucoma Syndromes

• Angle-Closure Glaucomas
  – Acute Primary Angle Closure
  – Plateau Iris Configuration
  – Aqueous Misdirection

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Acute Primary Angle Closure Glaucoma

• Demographics:
  – Elderly women
  – Asians

• Mechanism:
  – Contact between lens and iris creates resistance to aqueous flow from posterior to anterior chamber
  – Progressive anterior bowing of iris
  – Eventual/sudden closure of anterior chamber angle
  – Dramatic elevation of IOP

• Treatment
  – Topical and oral intraocular pressure-lowering medications
  – Laser peripheral iridotomy to restore aqueous flow
Acute Angle Closure Glaucoma

ZAP!

Figure 16-5. Patent iridectomy reduces pupillary block and equilibrates pressure in posterior and anterior chambers.
Acute Angle Closure Glaucoma

Angle Closure due to Relative Pupillary Block

- Iris against TM
- Sclera
- Convex iris
- Lens capsule
- Ciliary body
- Before laser iridectomy
- Flat iris
- TM in contact with aqueous
- After laser iridectomy

NYEEI, Ocular Imaging Center
Plateau Iris Configuration

- Abnormal anterior rotation of ciliary body processes push iris into peripheral angle

- Risk of appositional angle closure

- Often difficult to differentiate from narrow angles (until after successful iridotomy is placed, without resolution of anterior iris displacement)

- Treatment: Peripheral laser iridoplasty to force iris into flatter configuration or cataract surgery
Plateau Iris Configuration

- “Double hump” sign
Plateau Iris Configuration

• Laser peripheral iridotom y

Full-thickness opening

• Laser peripheral iridoplasty

Partial-thickness burn marks
Aqueous Misdirection Glaucoma

Demographics: RARE
Usually follows history of trauma (often surgical)
Aqueous Misdirection Glaucoma

Aqueous flows across/through discontinuity in anterior hyaloid face of vitreous body

Creates pocket of ever-expanding fluid within vitreous, pushes lens and iris forward into AC
Aqueous Misdirection Glaucoma

Hallmark: Markedly elevated intraocular pressures (50-70mmHg) with lens and iris fully in contact with cornea (diffusely shallow chamber)
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Acknowledgments

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Thank you