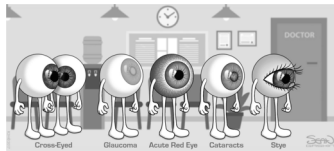


## Glaucoma



Nathan Law, MD  
Ophthalmology Resident  
Casey Eye Institute  
Oregon Health and Science University



## Learning Objectives

- Understand how to classify different types of glaucoma.
- Understand the tools used to assess for glaucoma and progression.
- Understand some of the different treatments.



## Overview

- Demographics
- What is glaucoma?
- Types of Glaucoma
- Monitoring for progression
- Treatment



## Demographics



### How big of a problem is Glaucoma?

#### US Patients > 40 years old with Primary Open-Angle Glaucoma

2011: 2.71 million Patients

2050: 7.32 million Patients

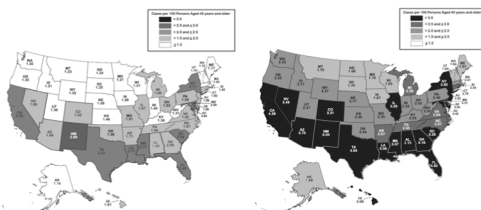


Image Courtesy: Vajaranant TS, et al. 2012.

2<sup>nd</sup> leading cause of blindness worldwide after cataracts



### Who is getting Glaucoma?

#### 2010 U.S. Prevalence Rates for Glaucoma by Age and Race

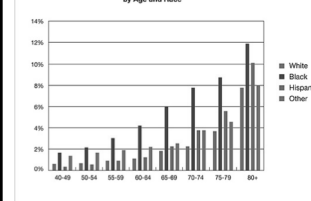


Image Courtesy: National Eye Institute, 2010 Open Angle Glaucoma Statistics

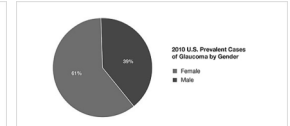


Image Courtesy: National Eye Institute, 2010 Open Angle Glaucoma Statistics

Risk Factor	Prevalence Rate
Increasing age	AGB, CDTG, EGPR, EMAC, CHITS
African ancestry	AGB, CDTG, CHITS, CHITS, LAMBERT
Visual field severity	AGB, EGPR, EMAC, CHITS
Distance refraction	AGB, CHITS, LAMBERT
Disc hemorrhage	CHITS, EMAC
Follow-up IOP	CHITS, EMAC
Color vision tests	EGPR, CHITS
Central corneal thickness	EGPR, CHITS
Refractive error	EMAC
Initial IOP	CHITS
Family size	AGB
Male sex	CHITS
Proliferative pressure	AGB
Hispanic ethnicity	CHITS, LAMBERT

AGB = Advanced Glaucoma Intervention Study; CHITS = Collaborative Initial Glaucoma Treatment Study; EMAC = Collaborative Initial Glaucoma Study; EGPR = European Glaucoma Prevention Study; LAMBERT = Early Medical Glaucoma Trial; LAMBERT = Early Medical Glaucoma Trial

Image Courtesy: BCSC 2018-2019.



## What is Glaucoma?



### What is Glaucoma?

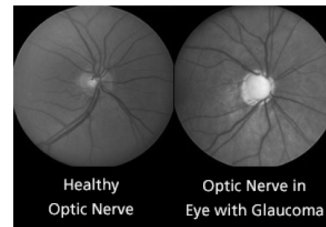
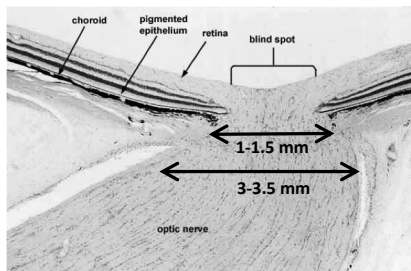


Image Courtesy: Glaucoma Research Foundation

the most common optic neuropathy worldwide ≠ high eye pressure



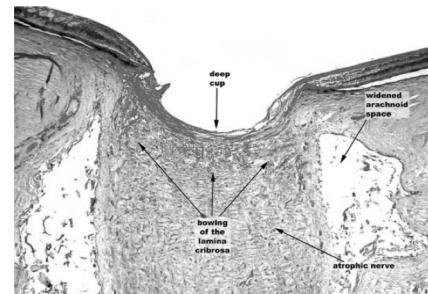
### Fundus Histology



~1,000,000 fibers from the Retinal Nerve Fiber Layer pass through the optic disc

Glaucoma Symptoms Appear at approx. 50% nerve fiber loss

Image Courtesy: American Academy of Ophthalmology, BCSC. 2009-2010.



Courtesy of Weng Sehu



### What is the cup and disc?

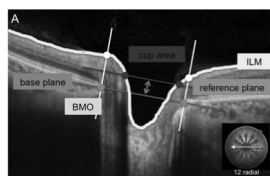
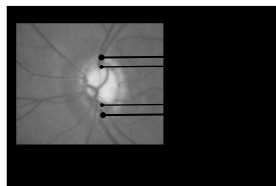


Image Courtesy: Takada N, et al. 2016.

"Normal" Cup-To-Disc Ratio:

0.1-0.4



## Types of Glaucoma



### Aqueous Humor Dynamics

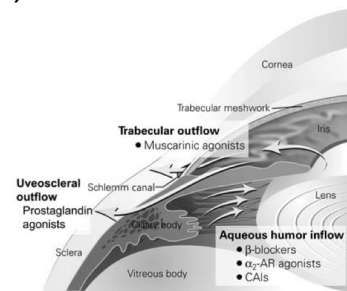


Image Courtesy: McLaren NC, et al. 2003.

### Assessing the Angle

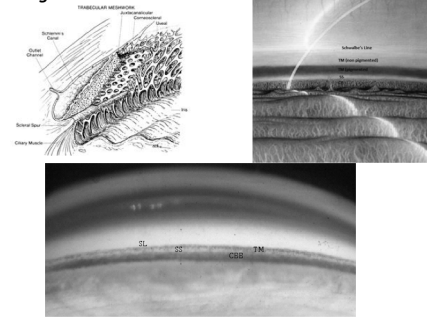
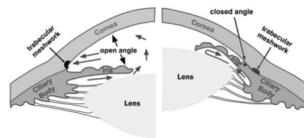


Image Courtesy: Alward WLM, Longmuir RA, 2017

## Types of Glaucoma

- Closed Angle
  - Primary Angle Closure
    - Acute
    - Chronic
  - Secondary Angle Closure
- Open Angle
  - Primary Open Angle Glaucoma
  - Normal Tension Glaucoma
  - Secondary Open Angle



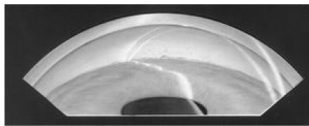
### Secondary Angle Closure

- Plateau Iris Syndrome
- Neovascular Glaucoma
- Iridocorneal Endothelial Syndrome
- Tumors
- Inflammation
- Malignant Glaucoma
- Epithelial and Fibrous Ingrowth
- Trauma
- Nanophthalmos
- Persistent Fetal Vasculature
- Drug Induced

### Secondary Open Angle Glaucomas

- Pseudoexfoliation Syndrome
- Pigment Dispersion Syndrome
- Lens Induced Glaucoma
- Intraocular Tumors
- Uveitic Glaucoma
- Elevated Episcleral Venous Pressure
- Trauma and Surgery
- Schwartz Syndrome
- Medication Induced Glaucoma

### What if the angle looked like this....?



If this happened acutely 360-degrees around, the patient is likely presenting as:



Acute Angle Closure Glaucoma

Image Courtesy: Alward WLM, Longmuir RA, 2017

## Monitoring for Progression

## Monitoring for Progression

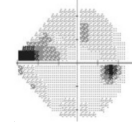
- Optic nerve exam
- Intraocular pressure
- Visual Fields
- OCT RNFL

### Consequences of Cupping

#### Inferior Nerve Damage

Loss of inferior temporal nerve fiber layer

24-2 Right Eye Humphrey Visual Field



SUPERIOR NASAL STEP  
VISUAL FIELD DEFECT

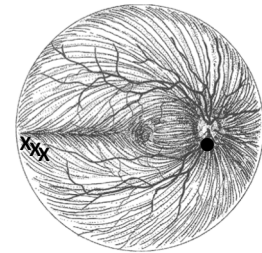


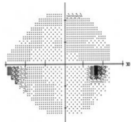
Image Courtesy: Alward WLM. 2000.

### Consequences of Cupping

#### Superior Nerve Damage

Loss of superior temporal nerve fiber layer

24-2 Right Eye Humphrey Visual Field



INFERIOR NASAL STEP  
FIELD DEFECT

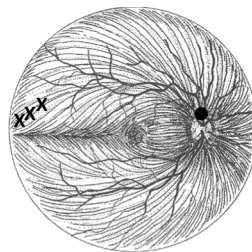


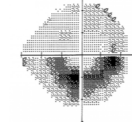
Image Courtesy: Alward WLM. 2000.

### Consequences of Cupping

#### Arcuate Nerve Damage

Loss of Superior Arcuate nerve fiber layer

24-2 Right Eye Humphrey Visual Field



INFERIOR ARCULATE VISUAL  
FIELD DEFECT

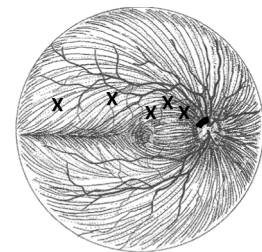


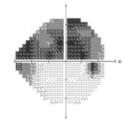
Image Courtesy: Alward WLM. 2000.

### Consequences of Cupping

#### Hemi-Nerve Damage

Loss of Inferior Hemi-field Nerve Fiber Layer

24-2 Right Eye Humphrey Visual Field



SUPERIOR ALTITUDINAL  
VISUAL FIELD DEFECT

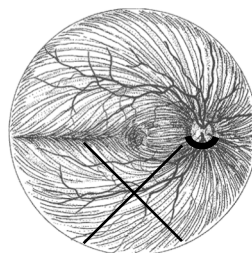
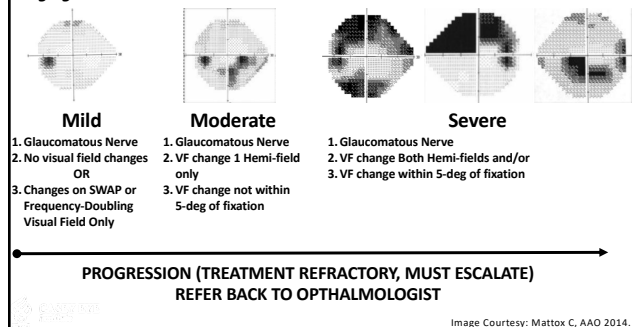
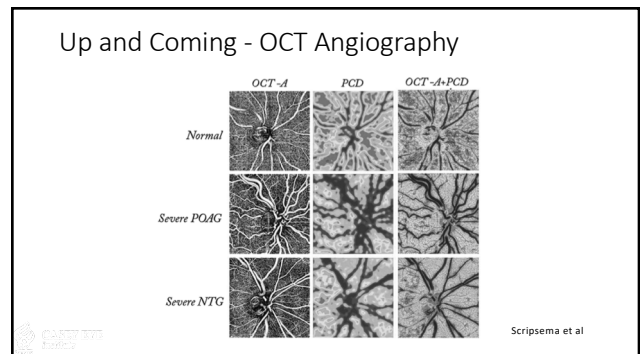
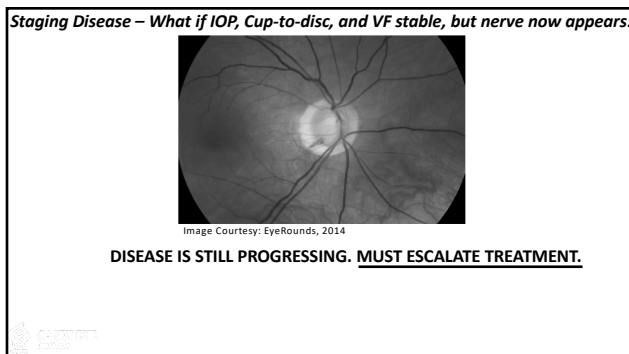
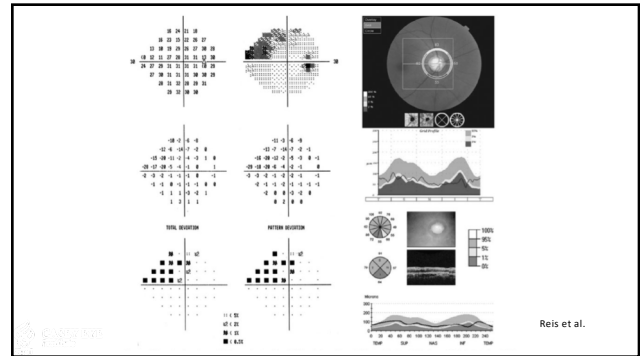
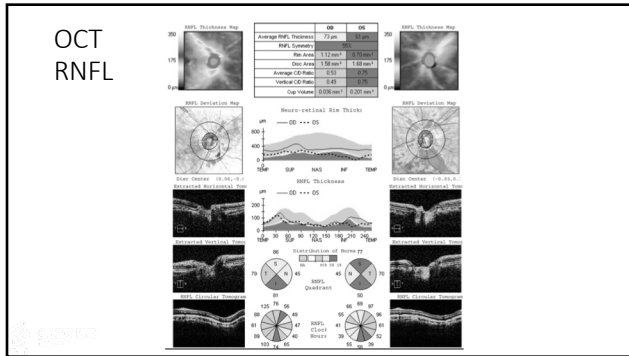


Image Courtesy: Alward WLM. 2000.

### Staging Disease



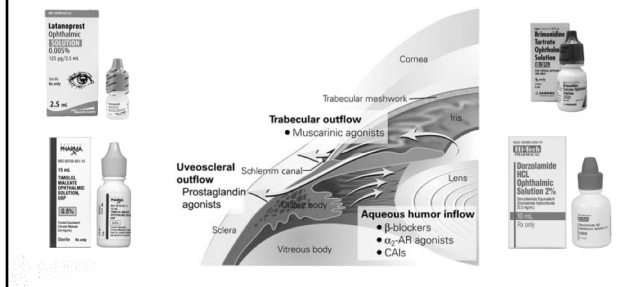


Treatment

Treatment

- Medical
- Lasers
- Surgical

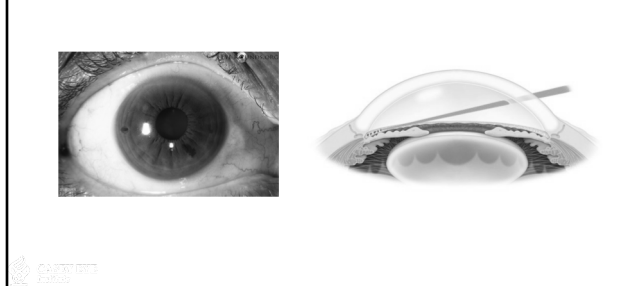
## Medical Management



## Up and Coming



## Lasers



### When to Refer for Iridotomy

**Acute Angle Closure Glaucoma** – If there is adequate corneal view, consider iridotomy placement

**Narrow Angles/Chronic Angle Closure** – Prophylactic iridotomy if:

- Angle occludable (< 180-deg trabecular meshwork on Gonioscopy)

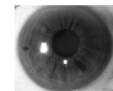


Image Courtesy: Vera V, et al. 2014.

### Surgery - When Medicine is Not Enough

**Trabecular Meshwork/Schlemm's Canal Remodeling:**

- Goniotomy
- Trabeculotomy
- Laser Trabeculoplasty
- Canaloplasty

**Filtration Surgery**

- Trabeculectomy

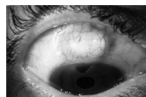


Image Courtesy: New Glaucoma Treatments, San Marino Eye, 2018.

**Tube Shunt**

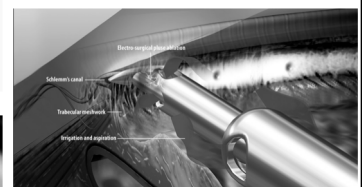
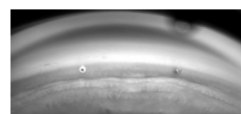
- Baerveldt Shunt
- Ahmed Valve



Image Courtesy: New World Medical, Rancho Cucamonga, CA.

**Cyclophotocoagulation**

### Up and Coming - MIGS



MIGS.org

### Parting Thoughts...

- Glaucoma is usually a slow, but progressive disease
- An important modifiable risk factor is IOP
- Serial exams, visual fields, and nerve fiber analysis are critical to monitoring progression
- Any progression requires medical or surgical treatment



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7. McLaren NC, Moroi SE. Clinical implications of pharmacogenetics for glaucoma therapeutics. *Pharmacogenomics J*. 3:197-201.(2003).



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10. Sun X, Dai Y, Chen Y, Yu D-Y, et al. Primary Angle Closure Glaucoma: What we know and what we don't know. *Progress in Retinal and Eye Research*. 57:26-45.(2017).
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12. Collaborative Normal-Tension Study Group. Comparison of Glaucomatous Progression Between Untreated Patients with Normal-Tension Glaucoma and Patients with Therapeutically Reduced Intraocular Pressures. *American Journal of Ophthalmology*. 126(4): 487-497. (1998).



### Overview

Extent of Primary Open Angle Glaucoma

Understanding Cup-to-Disc Assessment

Types of Visual Field Defects Common to Glaucomatous Injury

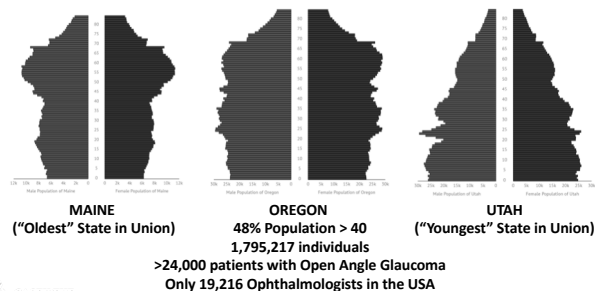
Risk Factors for Progression and Pressure Management

Aqueous Humour and the Anterior Chamber Angle

Angle Closure



### What about Oregon?



### Normal Tension Glaucoma

Patients with:

1. Glaucomatous Appearing Nerves
2. Visual Field Defects
3. Intraocular Pressure < 21

Comparison of Glaucomatous Progression Between Untreated Patients With Normal-Tension Glaucoma and Patients With Therapeutically Reduced Intraocular Pressures

COLLABORATIVE NORMAL-TENSION GLAUCOMA STUDY GROUP\*

1. IOP IS A FACTOR IN THE PATHOGENESIS OF NORMAL TENSION GLAUCOMA
2. LOWERING IOP BY 30% IS BENEFICIAL
3. RATE OF PROGRESSION ACCELERATES WITH FEMALE GENDER, H/O MIGRAINES, and DISC HEMORRHAGES



### Risk Factors for Nerve Damage from Primary Open Angle Glaucoma

#### CLINICAL SCIENCES

### The Ocular Hypertension Treatment Study

A Randomized Trial Determines That Topical Ocular Hypotensive Medication Delays or Prevents the Onset of Primary Open-Angle Glaucoma

Michael A. Kass, MD; Dale K. Heuer, MD; Eve J. Higginbotham, MD; Chris A. Johnson, PhD; John L. Keltner, MD; J. Philip Miller, AB; Richard K. Parrish II, MD; M. Roy Wilson, MD; Mae O. Gordon, PhD; for the Ocular Hypertension Treatment Study Group

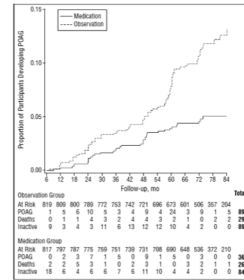
- **Baseline Intraocular Pressure - Modifiable**
- **Age**
- **Cup-to-disc ratio**
- **Central Corneal Thickness (CCT, < 555 microns)**

#### Other Risk Factors from Other Studies

Race  
Family History  
Diabetes  
Hypertension  
Myopia  
Migraines



### A Little More on Intraocular Pressure (IOP)



20% reduction in baseline IOP →

Risk of Visual Field Loss without Medication  
9.5%

Risk of Visual Field Loss with Medication  
4.4%

Image Courtesy: Kass MA, et al. 2002.

### Factors Favoring Angle Closure

#### Lens-Induced or Phacomorphic Glaucoma

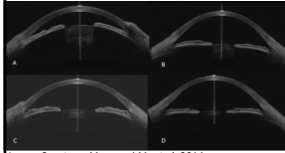


Image Courtesy: Mansouri M, et al. 2014.

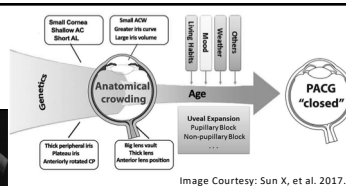


Image Courtesy: Sun X, et al. 2017.

- **Narrow Angle**
- **Shallow Anterior Chamber Depth**
- **Small Corneal Diameter**
- **Increased Lens Thickness**
- **Physiologic Mydriasis (natural large pupils)**
- **Pharmacologic Mydriasis (medical dilation)**
- **Multiple Systemic Medications**

