The Carter–Jenkins Center presents





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<u>Glaucoma</u>

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What is it ? How is it diagnosed ? How is it treated ?

What is Glaucoma?

Glaucoma is a potentially blinding eye disease usually caused by elevated pressure within the eye.

It is the <u>second-most common</u> cause of irreversible blindness in the USA, after macular degeneration.

It is the <u>most common</u> cause of irreversible blindness in the world.

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Visual field with no glaucoma. "Blind Spot" is normal.



Visual Field with severe damage due to glaucoma. Vision in superior hemifield is almost totally lost, but central vision is preserved. It could still be 20/20 !



Visual Fields LEFT Eye, on left, and RIGHT Eye. Central vision in LEFT eye may or may not still be preserved.



Series of Visual Fields, showing progressive worsening

How is Glaucoma diagnosed?

By a thorough eye exam, which includes measurement of intraocular pressure and examination of the optic nerve

How is Glaucoma treated?

Treatment options include eye drops, laser treatment, oral medications, and surgery. Important things to know about glaucoma

The exact cause of most glaucoma is not known!

It becomes more common as people grow older , but it can affect any age group, including newborn babies!

> In most cases it is not CURABLE, But it is CONTROLLABLE

PRIMARY CONGENITAL GLAUCOMA



First: VISION

- A TOTALLY DETAILED AND COMPREHENSIVE EXPLANATION OF HOW WE SEE IS LACKING
- SIGHT IS INEVITABLY LINKED WITH THE MYSTERY
 OF HUMAN CONSCIOUSNESS
- SCHRÖDINGER: "CONSCIOUSNESS MAY NEVER BE UNDERSTOOD"
- CLINICIANS ARE MORE LIKE ENGINEERS (MORE LIKE TECHNICIANS?) THAN THEY ARE LIKE SCIENTISTS OR PHILOSOPHERS
- HOW CAN WE REPAIR A MALFUNCTIONING BIOMECHANICAL SYSTEM, SUCH AS THE EYE WITH GLAUCOMA?



Physicist Erwin Schrödinger Austrian, 1887-1961

 $H\psi(\mathbf{r},t) = \mathrm{i}\hbar\frac{\partial}{\partial t}\psi(\mathbf{r},t).$

Schrödinger's Equation

Why do we see what we see?

What do you think? Actually , nobody knows!

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Physicist Max Planck German, 1858-1947



Planck's Equation





The eye is the camera.

The brain is the computer.

The optic nerve connects the eye to the brain.

Glaucoma can destroy the optic nerve!





GLAUCOMA FEATURES - I

- HALF THE PEOPLE WITH GLAUCOMA IN THE USA ARE UNAWARE THAT THEY HAVE THE DISEASE, SINCE IT IS USUALLY ASYMPTOMATIC
- CENTRAL VISION IS USUALLY GOOD UNTIL LATE IN THE DISEASE; ONLY PERIPHERAL VISION IS DAMAGED

GLAUCOMA FEATURES - 2

- PROGRESSIVE ATROPHY OF THE OPTIC NERVE, USUALLY ASSOCIATED WITH ELEVATED INTRAOCULAR PRESSURE (IOP)
- IT IS UNKNOWN WHETHER THE ATROPHY IS CAUSED DIRECTLY BY MECHANICAL EFFECTS OF PRESSURE, BY RESTRICTION OF BLOOD FLOW DUE TO PRESSURE, OR BY SOMETHING ELSE
- DAMAGE, ONCE IT OCCURS, IS PERMANENT



"COAG"

- Chronic Open Angle Glaucoma
- Most common form of glaucoma in U.S.
- Elevated Intraocular Pressure is usually involved
- Exact reason for IOP elevation is unknown









What the doctor sees when he measures your Intraocular pressure by applanation

GLAUCOMA TREATMENT

Only known treatment is to lower the pressure enough so that no more damage occurs.

Glaucoma Treatment: Difficulties

- How low is low enough?
- Too low and the eye goes blind from low pressure!
- Why not do surgery on every eye and get the pressure down once and for all?
- "Perfect" glaucoma surgery (or any surgery) does not exist!













Nerve Fiber Layer

Ganglion Cells

Inner Plexiform Layer

Bipolar and Horizontal Cells

Outer Plexiform Layer

Photoreceptors (Rod & Cone Cells)

Retinal Pigment Epithelium (RPE) Bruch's Membrane Choroid



Glaucoma can't be cured!

- An eye transplant is impossible!
- Can't cut and resuture the optic nerve!
- I.2 million nerve fibers in I.2 mm diameter structure!
- Only known treatment is to lower pressure enough to "freeze" damage that exists and prevent further damage
- How do we know that existing damage is in fact stable?

GLAUCOMA FEATURES – 2

- A CLINICAL PARAMETER USED UNIVERSALLY TO FOLLOW GLAUCOMA DAMAGE IS THE SO-CALLED "CUP/DISK RATIO"
- THIS IS THE RATIO OF THE DIAMETER OF THE "CUPPED" REGION OF THE NERVE TO THE OVERALL DIAMETER OF THE NERVE
- IT IS ESTIMATED SUBJECTIVELY BY THE CLINICIAN OR MEASURED WITH VARIOUS IMAGING DEVICES







Cup/Disk ratio can fool you, due to variation of disk diameter

A normal nerve may have a large C/D

A damaged nerve may have a small C/D

There is no "minimum" C/D that corresponds to "damage"

GLAUCOMA FEATURES - 3

- THE CURRENT "GOLD STANDARD" FOR MONITORING GLAUCOMA DAMAGE IS THE AUTOMATED, COMPUTERIZED VISUAL FIELD TEST
- THIS IS A <u>SUBJECTIVE TEST</u>, IN THAT IT DEPENDS CRITICALLY ON THE PATIENT'S ATTENTION AND COOPERATION







Optical Coherence Tomography (OCT)

- May someday replace visual fields
- It is objective
- So far, it is not good enough



GLAUCOMA PLUMBING

- IF OUTFLOW IS OBSTRUCTED BY THE IRIS, DIAGNOSIS IS "<u>ANGLE-CLOSURE</u> <u>GLAUCOMA</u>" (COMMON IN ASIA AND IN FAR-SIGHTED PEOPLE)
- IF THERE IS NO CLINICALLY DETECTABLE OBSTRUCTION OF OUTFLOW, DIAGNOSIS IS "<u>OPEN ANGLE GLAUCOMA</u>"
 =COAG=POAG (MORE FREQUENT IN PEOPLE OF EUROPEAN DESCENT)

CLOSED ANGLE Schlemm's canal Episcleral vein Aqueous vein

Trabecular meshwork-

Ciliary body

Aqueous flow

Iris



Gonioscopy

- Method used clinically to examine the anterior chamber angle
- Every new patient should have gonioscopy, but this is NOT routinely done in eye clinics, even on hyperopes (big mistake)



INTRAOCULAR PRESSURE

- NORMAL IS 10-20 mmHg, OR APPROX 1.01-1.02 ATM
- I.03 ATM: SLOW DAMAGE (YEARS)
- I.04 ATM: MONTHS
- 1.05 ATM: DAYS
- I.06 ATM: HOURS
- 2.00 ATM (SCUBA AT 32 FT): NO DAMAGE!!

GLAUCOMA TREATMENT

- GLAUCOMA DAMAGE CANNOT BE REVERSED WITH ANY KNOWN TREATMENT
- LOWERING IOP CAN STABILIZE
 GLAUCOMA AND "FREEZE" OPTIC
 NERVE DAMAGE IN MOST CASES
- IOP CAN BE LOWERED USING DROPS, PILLS, LASER, OR SURGERY

Glaucoma Treatment

- Drops
- Lasers
- Pills
- Surgery



Trabeculectomy

Glaucoma Drainage Devices



Ahmed Valve® Implant



Tube shunt in eye which has also had previous laser iridotomy M-31 Andromeda Galaxy

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<u>Glaucoma</u>

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