INTRAOCULAR PRESSURE MEASUREMENT

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GOALS:
What is (normal) IOP?
Why do we measure IOP?
How do we measure IOP?
How do we control infection/contamination?

WHAT IS INTRAOCULAR PRESSURE?
INTRAOCULAR PRESSURE (IOP)

- Pressure inside eye
- Measured as part of routine eye exam
- Units: mmHg (millimeters of mercury)

IOP is the most prominent and consistent glaucoma risk factor
INTRAOCULAR PRESSURE (IOP)

- AVERAGE IS 15.5mmHg
  - Sometimes we say “10-20 mmHg”
  - Within two standard deviations of 15.5mmHg
- 10% OF ADULTS HAVE IOP >20mmHg

INTRAOCULAR PRESSURE (IOP)

- CAN CHANGE THROUGHOUT THE DAY OR OVER VISITS ON THE SAME PERSON

WHAT CAN CHANGE IOP?
WHAT CAN CHANGE IOP?

CRYING

WHAT CAN CHANGE IOP?

TIGHT NECKTIE

WHAT CAN CHANGE IOP?

VALSALVA MANEUVER
WHAT CAN CHANGE IOP?

RAPID FLUID INTAKE

WHAT CAN CHANGE IOP?

ALCOHOL CONSUMPTION

WHAT CAN CHANGE IOP?

SYSTEMIC MEDICATION (HTN)
WHAT CAN CHANGE IOP?

STEROID EYE DROPS

WHAT CAN CHANGE IOP?

PLAYING A WIND INSTRUMENT

WHAT CAN CHANGE IOP?

POSITION (SUPINE VS. SITTING)
WHAT CAN CHANGE IOP?

TIME OF DAY/NIGHT

IOP IS HIGHER AT NIGHT


IOP IS POSITIONAL

18-25 years
N=21

WHAT CAN CHANGE IOP?

REFRACTIVE SURGERY

WHAT CAN CHANGE IOP?

CORNEAL THICKNESS

PACHYMETRY
PACHYMETRY
- Thin: <555um  Higher Risk
- Avg: 555-588um  No Change in Risk
- Thick: >588um  Lower Risk

WHAT CAN CHANGE IOP?
- Holding breath
- Crying
- Examiner pushing on eye
- Valsalva maneuver
- Tight necktie
- Playing a wind instrument
- Rapid fluid intake
- Medications
- Steroid eye drops
- Corneal thickness
- Thick corneas  Overestimate IOP
- Thin corneas  Underestimate IOP
- Refractive surgery
- Pregnancy
- Alcohol and other drugs

MEASURING IOP
SCHIOTZ TONOMETER (HISTORICAL)

- CHEAP
- PORTABLE
- REQUIRES ANESTHETIC
- WEIGHTED PLUNGER INDENTS CORnea

GOLDMANN APPLANATION TONOMETRY

- GOLD STANDARD

GOLDMANN APPLANATION TONOMETRY

- TONOMETER PRISM
  - multi-use or single-use
GOLDMANN APPLANATION TONOMETRY

- REQUIRES ANESTHETIC AND YELLOW DYE
  - proparacaine
  - sodium fluorescein

GOLDMANN APPLANATION TONOMETRY

- APPLANATION METHOD
  - tonometer prism flattens cornea over 3.06mm

GOLDMANN TECHNIQUE
LIMITATIONS

• MAY NOT WORK ON ALL PATIENTS
  – requires slit lamp
  – handheld versions available
• ALTERNATE: PERKINS Tonometer
  – vertical or horizontal use

GOLDMANN APPLANATION TONOMETRY

• MOST ACCURATE AT 520UM CORNEAL THICKNESS
  – normal 555um

GOLDMANN APPLANATION TONOMETRY

• IOP IS 10X WHAT DIAL READS
• CORNEAL ASTIGMATISM/CYLINDER CAN AFFECT READING
GOLDMANN APPLANATION TONOMETRY

- CENTRATION AND/OR THICKNESS OF MIRES CAN AFFECT PRESSURE READING
  - Thin mires will underestimate IOP
  - Thick mires will overestimate IOP

MIRES

TONOPEN

- USES ELECTRONIC STRAIN GAUGE TO FLATTEN CORNEA
- INSTRUMENT BEEPS AS INTERIM MEASUREMENTS TAKEN
**USING A TONOPEN**

- 4-10 READINGS
- REQUIRES ANESTHETIC
- WORKS WELL ON DISEASED CORNEAS
- CAN BE USED OVER BANDAGE CONTACT LENS
- STATISTICAL INDICATOR (CONFIDENCE) GIVEN – 95% CI

**TONOPEN**

- DISPOSABLE TIP COVERS
- BATTERIES
- $$
- FAST
NON-CONTACT TONOMETRY (NCT)

• USES "PUFF" OF AIR TO FLATTEN CORNEA
• NO ANESTHETIC NEEDED
• FAST

NON-CONTACT TONOMETRY (NCT)

• WORKS WELL AT NORMAL RANGE OF 10-20MMHG
• STILL VARIABLE
• NOT OK TO MANAGE GLAUCOMA
  – 1998 guidelines from Glaucoma Research Foundation
  – not as accurate at high IOPs

ICARE TONOMETRY

• REBOUND TONOMETER
• DISPOSABLE TIPS
• DEVELOPED FOR USE IN ANIMALS
ICARE TONOMETRY
• NO ANESTHETIC NEEDED
• GREAT FOR YOUNG KIDS
• LESS INTIMIDATING FOR PATIENTS

ICARE TONOMETRY
• REQUIRES 6 GOOD REBOUNDS
• THEN AVERAGE MEASUREMENT IS GIVEN

NEWER MEASUREMENT METHODS
DYNAMIC CONTOUR TONOMETRY (PASCAL/DCT)

• CONTOUR MATCHING (NOT APPLANATION)
• ELIMINATE ERROR DUE TO STRUCTURE
  – corneal thickness
  – corneal rigidity
  – corneal curvature
  – corneal elasticity

DYNAMIC CONTOUR TONOMETRY (PASCAL/DCT)

• SIMILAR IN APPEARANCE TO GOLDMANN
• MINIATURE PIEZORESISTIVE PRESSURE SENSOR EMBEDDED WITHIN TIP
• CONTOUR-MATCHED TO SHAPE OF THE CORNEA

DCT
**Dynamic Contour Tonometry (Pascal/DCT)**

- Measures IOP 100X/Second
- Entire measurement sequence: 8 seconds

**Transpalpebral (Diaton) Tonometry**

- Measures through upper eyelid
- Helpful in eyes with corneal prosthetics (KPRO)
CORNEAL HYSTERESIS (CH)
- Difference between the pressure at which the cornea bends inward during applanation and the pressure at which it bends out again
- Measures biomechanical property of cornea related to elasticity
- Average 9.6-10.7 in normal; lower in POAG (8-10)
- Ocular Response Analyzer (Reichert)
- Corvis ST (Oculus) - Similar

SENSIMED TRIGGERFISH
- "Smart" contact lens fit for 24-HR IOP monitoring in glaucoma
- 2 visits x 30 min each (fit/remove)
- Normal ADLs during wear
- No optical correction
- FDA approved (2016)
- Does not measure in mmHg (units arbitrary)

HOW IT WORKS...
- Embedded strain gauge
- "Spontaneous circumferential changes at the corneoscleral area"
- Direct correlation to IOP
DISINFECTION METHODS

GOLDMANN PRISM
- SOAKING SOLUTION
  - BLEACH 1:10 dilution
  - 5 min (10?)
  - kills adenovirus, HSV
- NO ISOPROPYL ALCOHOL
- NO HYDROGEN PEROXIDE
- NO ACETONE
- REPLACE Q2YR/100 CYCLES OR WHEN DAMAGED
- INSPECT FOR DAMAGE WITH SLIT LAMP @16X

TONOMETER DISINFECTION (H-S PACKAGE INSERT)
- CLEAN WITH PALMOLIVE 0.08% (MILD SOAP)
- RINSE WITH STERILE SALINE (NOT TAP WATER)
- SOAK IN BLEACH (1:10) OR H2O2 (3%)
  - 10 minutes (60 minutes max exposure time)
  - Replace solution daily
- RINSE W/ COLD RUNNING WATER (10 MIN BLEACH/5 H2O2)
- TISSUE DRY AND STORE IN CLEAN, DRY CONTAINER

HTTP://OPTOMETRYTIMES.MODERNMEDICINE.COM/OPTOMETRYTIMES/CONTENT/TAGS/CONTACT-LENS-DISINFECTION/INFECTION-CONTROL-EYECARE-OFFICE
TONOPEN

- DISPOSABLE TIP COVERS

ICARE TONOMETER

- SINGLE USE TIPS
  – discard after use

TREATING ELEVATED IOP
TREATING ELEVATED IOP

• TOPICAL DROPS
• LASER TREATMENT
• SURGICAL INTERVENTION

DROPS

• LATANOPROST (#79)
• BRIMONIDINE (#167)
• BIMATOPROST
• TRAVAPROST
• COMBIGAN (BRIMONIDINE + TIMOLOL)
• RHOPRESSA (AERIE PHARMACEUTICALS)
• VYZULTA (BAUSCH + LOMB)

LASER

• ARGON LASER TRABECULOPLASTY (ALT)
• SELECTIVE LASER TRABECULOPLASTY (SLT)
• LASER PERIPHERAL IRIDOTOMY (LPI)
• LASER IRIDOPLASTY
• TRANSSCLERAL CYLCOPHOTOCOAGULATION

**SURGERY**

- TRABECULECTOMY
- GLAUCOMA DRAINAGE IMPLANTS (GDI/TUBE SHUNT)
  - Differ in size, shape, presence of valve
  - Minimally invasive glaucoma surgery (MIGS)
    - iStent (FDA approved 2012)
    - in conjunction with cataract surgery

**CAUTIONS**

WHAT CAN CHANGE IOP?

- HOLDING BREATH
- CRYING
- EXAMINER PUSHING ON EYE
- VALSALVA MANEUVER
- TIGHT NECKTIE
- PLAYING A WIND INSTRUMENT
- RAPID FLUID INTAKE
- MEDICATIONS
  - STEROID EYE DROPS
  - CORNEA THICKNESS
  - THICK CORNEAS OVERESTIMATE IOP
  - THIN CORNEAS UNDERESTIMATE IOP
  - REFRACTIVE SURGERY
  - PREGNANCY
  - ALCOHOL AND OTHER DRUGS
GLAUCOMA SCREENINGS

“SCREENINGS THAT RELY ON AN EYE PRESSURE TEST MAY MISS OVER HALF OF THOSE WHO HAVE GLAUCOMA.”

—GLAUCOMA RESEARCH FOUNDATION, AAOPHTH, AOA JOINT STATEMENT (1998)

REFERENCES