Potential New Mechanism of Damage in Glaucoma

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The Eye

- IOP
  = Intraocular Pressure

- IOP is due to fluid volume in the eye

https://nei.nih.gov/health/glaucoma/glaucoma_facts
IOP is Pulsatile!

• OPA = Ocular Pulse Amplitude

• OPA is peak to valley magnitude
Optic Nerve

- Cerebrospinal Fluid = CSF

- CSF bathes the brain to generate intracranial pressure (ICP), and bathes the optic nerve!
- ICP directly impinges on the eye

ICP is Pulsatile!

- CSFP = CSF pressure
- Single patient as CSF is drained
Literature: ICP

- POAG, NTG < Controls
  - Primary Open Angle Glaucoma (POAG)
  - Normal Tension Glaucoma (NTG)
- Ocular Hypertension (OHT) > Controls

Limitations of *Berdahl, et al*

- Retrospective Design
- All subjects had other neurological symptoms for which lumbar puncture was done
- IOP and ICP were not measured on the same date or same position
- Did not measure OPA
Our Hypothesis

- Ocular Pulse Amplitude (OPA) will interact with CSFP Pulse Amplitude (CPA)
Hypothesis

- The magnitude of the **pulsatile** component of the **translaminar pressure gradient** will correlate with **glaucomatous damage**.
  
  - Translaminar Pressure Gradient = TLPG
  - Translaminar Pulse Amplitude = TPA
  - Cerebrospinal Fluid Pressure (CSFP)

- Lamina Cribrosa is major site of Damage in Glaucoma
Hypothesis

• Normal intracranial pressure (ICP) and greater CPA buttress the lamina cribrosa and protects it from the action of the ocular pulse amplitude (OPA)

• Lower intracranial pressure in gluacoma and lower CPA exposes the lamina cribrosa to the repeated stretching action of the OPA
Spatial Effect of IOP and ICP

- IOP is distributed over the entire eye
  - Changes in volume/pressure result in a change in the diameter of the eye with each pulsation
  - Measureable on the cornea!
  - 60 beats/minute = over 31,000,000 beats/year

- ICP is present ONLY behind and around the lamina cribrosa
  - Potentially buttresses the lamina
  - Protect lamina from the action of the OPA?
Ongoing OSU Study Methods

• 130 Subjects to be recruited
  – **30 POAG** – Primary Open Angle Glaucoma (high pressure, nerve damage)
  – **15 NTG** – Normal Tension Glaucoma (normal pressure, nerve damage)
  – **15 OHT** – Ocular Hypertension (high pressure, NO damage)
  – **60 Normal** (normal pressure, NO damage)
How is ICP measured?
Standard Procedure – SLOW while waiting for fluid to rise

http://webmedia.unmc.edu/LumbarPuncture/lpProcedure.htm


It is possible retrospective study used values that were UNDER-ESTIMATED
Our Procedure:
Electronic Measurement of CSF Pressure during Lumbar Puncture

- NO FLUID REMOVAL REQUIRED
- SMALL NEEDLE!
Lateral Decubitus (LD) Position
Subject experience reported at ARVO:
Ultrasound-Guidance of Spinal Needle Placement

L4 L5 S1

SonoSite Model M-Turbo
CSFP and Arterial Pulsations both reflect Cardiovascular Events
No Results Yet

• Almost Fully Enrolled

• **Still Need OHT and NTG subjects!!!**

• However, examples can be shown
OPA and CPA in 4 Subjects

IOP and ICP

Pressure (mmHg) vs. Time (s)
Ocular Pulse Amplitude (OPA) vs Cerebral Pulse Amplitude (CPA)

Lamina Cribrosa

Space between optic nerve and optic sheath filled with cerebrospinal fluid
Future Directions

• Continue Enrollment

• Data Analysis

• Presentation and Publication!!
Thank You!!
Chart Title