LASER PROCEDURES FOR THE MANAGEMENT OF GLAUCOMA AND MORE!

NATHAN LIGHTHIZER, O.D., F.A.A.O.

Overview
- Why we use lasers
- YAG capsulotomy
- Laser Peripheral Iridotomy (LPI or PI)
- Argon Laser Peripheral Iridoplasty (ALPI)
- Argon Laser Trabeculoplasty (ALT)
- Selective Laser Trabeculoplasty (SLT)
- Endoscopic Cyclophotocoagulation (ECP)

Why do we use lasers?
- Vision is decreased from PCO following cataract surgery
- Narrow angles/angle closure
- Glaucoma is progressing in a pt on max meds
  - Something else needs to be done
  - Surgery not wanted yet
- Compliance issues
- Cost issues
- Convenience issues
- Doctor preference

Posterior Capsular Opacification (PCO)
- Lens capsular bag has an anterior and posterior surface
  - Anterior surface usually removed w/ capsulorhexis
- PCO is the formation of a cloudy membrane on the posterior surface of the capsular bag following ECCE
  - AKA: Secondary cataract

YAG Capsulotomy

PCO
- Incidence:
  - Most common complication of post ECCE
  - 10-80% of eyes following cataract surgery
  - Can form anywhere from a few days to years post surgery
  - Younger patients higher risk of PCO
  - IOL's
    - Silicone > acrylic
- Prevention:
  - Capsulotomy during surgery
  - Posterior capsular polishing
**Nd: YAG Laser**
- Neodymium: Yttrium aluminum garnet laser
- Tissue interaction: Photodisruptive laser
  - High light energy levels cause the tissues to be reduced to plasma, disintegrating the tissue
  - A large amount of energy is delivered into very small focal spots in a very brief duration of time
  - 4 nsec
  - No thermal reaction/No coagulation when bv’s are hit
  - Pigment independent
- Visual acuity, glare testing, PAM/Heine lambda
- Vision 20/30 or worse
- Slit Lamp Exam
- IOP’s
- Dilate – will be able to visualize the PCO much better
- Posterior segment exam
  - Macula
  - Periphery
- Educate Pt
- Informed Consent Signed

**YAG Cap Pre-op**
- Visual acuity, glare testing, PAM/Heine lambda
  - Vision 20/30 or worse
- Slit Lamp Exam
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- Dilate – will be able to visualize the PCO much better
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**YAG Cap Risks, Complications, Contraindications**

<table>
<thead>
<tr>
<th>CONTRAINDICATIONS</th>
<th>RISKS/COMPLICATIONS</th>
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</thead>
<tbody>
<tr>
<td>1. Corneal problems</td>
<td>1. IOP spike/elevation</td>
</tr>
<tr>
<td>2. Intraocular inflammation</td>
<td>2. Most often transient</td>
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<tr>
<td>3. Macular problems</td>
<td>3. Inflammation</td>
</tr>
<tr>
<td>4. Patient unable to hold steady or fixate</td>
<td>4. Pred Forte QID X 1 week</td>
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<tr>
<td>5. Floaters</td>
<td>5. Use appropriate laser energy</td>
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<tr>
<td>6. Retinal detachment</td>
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<td>7. Permanent vision loss</td>
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**YAG Cap Procedure**
- Patient Pre-op Drops
  - Dilating drops
  - 1 drop Alphagan or Iopidine 15-30 minutes prior to
- Laser Settings
  - Energy 1.3 – 2.5 mJ
  - Spot Size fixed
  - Duration fixed
  - Pulses 1
  - Offset 250 microns

**YAG Cap Procedure**
- Sit patient comfortably
- Adjust laser for your comfort
  - Armrest, oculars, controls
- Instill proparacaine in both eyes
- Place laser lens on eye with goniosol or celluvisc
  - Advantages of laser lens:
    - Stabilizes the eye/lid control
    - Helps prevent eye from drying out
  - Disadvantages of laser lens:
    - Complicates/slow the procedure
    - Reflections & bubbles
    - Some patients can’t tolerate the lens
- Focus HeNe beams on the PCO
- Perform the procedure
  - No pain for patients
  - May feel popping/snap/clap in ears
- Usually done in a cruciate pattern
- Other patterns:
  - Horseshoe
  - Circular
YAG Cap Procedure

- Post-op Care
  - Remove laser lens
  - Rinse Eye/Clean eye
  - 1 drop of Alphagan or Iopidine post-laser
  - IOP measurement 15-30 minutes post-laser

- Post-op drops
  - Pred Forte QID to surgical eye X 1 week
  - Pt ed = S/S of RD

- RTC 1 week for f/u

I week post-operative exam

- VA’s
- Anterior segment exam
  - Check for cell/flare
  - Check IOP
  - Dilate
    - Check for holes/tears/RD’s

- D/C Pred Forte
- Release back to referring doc

YAG Cap

- Reimbursement codes
  - 66821 $295.53

- 90 day global period

Anatomically Narrow Angles / Angle Closure

- Anatomic disorder characterized by peripheral iris & TM apposition
- 4 basic forms:
  - Pupillary block
  - Plateau iris
  - Phacomorphic glaucoma
  - Malignant glaucoma
**PI Indications**
- Primary angle closure
- Plateau iris syndrome/configuration
- Secondary pupillary block
  - Phacomorphic, malignant glaucomas
- Pigmentary glaucoma
- Prophylaxis*
  - Narrow angles on gonioscopy
  - Most often reason why PI is done

**PI Alternatives**
- Surgical Iridectomy
  - Equal results to laser PI
  - Much more invasive
    - More trauma to iris
    - Infection
  - If concurrent surgery not occurring, laser PI is the way to go

**PI Pre-op Exam**
- Visual acuity
- Slit Lamp Exam OU
  - Note lid position
  - Note AC depth
- Gonio OU
  - Pigment in the TM?
  - Neovascularization?
  - Peripheral anterior synechiae?
- IOP’s OU
- Educate Pt
- Informed Consent Signed

**PI Risks, Complications, Contraindications**

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<td>3. Iris in contact with endo</td>
<td>3. Most often transient</td>
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<td>4. Angle closure from NVG or inflammatory glaucoma</td>
<td>4. Inflammation</td>
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<td>5. Patient unable to hold steady or fixate</td>
<td>4. Pron Forte QID X 1 week</td>
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<td>6. Macular problems?</td>
<td>5. Use appropriate laser energy</td>
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**PI Procedure**
- Patient Pre-op Drops
  - 1 drop Pilocarpine 1% or 2% OU
  - 1 drop Alphagan or Iopidine OU
- Laser Settings
  - Depends on which laser you use

**PI Laser Options**

**ARGON LASER**
- Less commonly used
- Advantages:
  - Less bleeding
- Disadvantages:
  - Less successful compared to YAG laser in penetration
- Settings:
  - Spot size = 50 microns
  - Duration = 0.1 sec
  - Power = 300-1200 mW

**YAG LASER**
- More commonly used
- Advantages:
  - Very good penetration rate
- Disadvantages:
  - More likely to bleed
  - Much more debris
- Settings:
  - Spot size = fixed
  - Duration = fixed
  - Energy = 2.0 – 5.0 mJ
  - Offset = 0 – 250 microns
**PI Procedure**
- Sit patient comfortably
- Adjust laser for your comfort
- Armrest, oculars, controls
- Instill proparacaine in both eyes
- Select PI location
  - Usually superiorly under lid
  - Crypt
  - 1:00 or 3:00
- Place Abraham Iridotomy laser lens on eye with goniosol or celluvisc
  - Orientation of lens matters
  - Button at 11 or 1 o’clock (for a superior PI)
- Focus HeNe beams on the iris
- Perform the procedure OU
  - Argon first for pre-treatment
  - YAG to finish PI
  - No pain for patients - usually
  - May feel popping/snap/clap in ears
  - Takes longer than a YAG Cap
    - Occasional bleeding
    - Debris/pigment
      - “pigment plume”

**Goals:**
- patent PI = 1mm in size
- Deepening of the AC
- IOP control

**Post-op Care**
- Remove laser lens
- Rinse Eye/Clean eye
- 1 drop of Alphagan or Iopidine post-laser
- IOP measurement 30 minutes post-laser

**Post-op drops**
- Pred Forte QID to surgical eye X 1 week
- Pt ed
- RTC 1 week for f/u

**Peripheral Iridotomy (PI)**
- Reimbursement codes
  - 66761 $295.50
- 10 day global period

**Plateau Iris Syndrome**
- Development of residual angle closure after patent Laser Peripheral Iridotomy (LPI)
  - Flat iris plane
  - Deep anterior chamber
  - Narrow angle due to anterior insertion of iris root
  - Dilation, being in a dark environment often promotes bunching of peripheral iris in the angle
- Consider the demographics
  - 20-50 year old Caucasian females seem to be the most prominent demographic
Also known as Laser Gonioplasty
Used to deepen the anterior chamber angle and make angle structures more easily visible
Scars the peripheral iris causing it to shrink and pull away/out of the angle
Most commonly used for:
- Plateau Iris Syndrome
- Opening up the angle for ALT/SLT

Pre-laser drops
- 1-2% Pilocarpine
- Alphagan or Iopidine
Use same lens as used during Peripheral Iridotomy
- Abraham lens

Procedure
- Long duration pulses (0.5 seconds)
- Large Spot Size (500 microns)
- Low Energy (200 mW)
  - Can increase in 40-50 mW increments until iris stromal contraction is seen
- 20-25 burns put in a circular fashion around the peripheral iris
  - 6 per quadrant

Complications:
- IOP spike
- Inflammation
- PAS
  - Studies have shown this really doesn’t happen

Long-term
- Studies show ALPI lasts for years

Reimbursement codes
- 66762 $425.70
- 90 day global period
Glaucoma is progressing in a pt on max meds
- Something else needs to be done
- Surgery not wanted yet
- Compliance issues
- Cost issues
- Convenience/quality of life issues
- Systemic side effect issues of drops
- Doctor preference

Laser Trabeculoplasty (LTP)
- Use of laser light to burn areas of the TM to increase aqueous outflow
- Two types
  - Argon laser trabeculoplasty (ALT)
  - Selective laser trabeculoplasty (SLT)
- Both increase aqueous outflow

Laser Trabeculoplasty (LTP)
- Most common laser procedure for OAG
  - ALT in the 90’s and early 2000’s
  - SLT has largely taken over
- Usually a Secondary Line of Treatment
  - After meds fail to control IOP
  - Some use as Primary Treatment
- Universally Accepted

LTP Indications
- POAG
- Normo-tensive glaucoma
- Pigmentary dispersion glaucoma
- Pseudoxfoliative glaucoma

LTP Contraindications
- Advanced POAG
- Narrow Angle Glaucoma
- Angle Closure (Emergency IOP decrease)
- Inflammatory Glaucoma
- Angle Recession Glaucoma
- Neovascular Glaucoma
- Congenital Glaucoma
- Prior LTP that failed
- Under 40 years of age
- Hazy media
Traditional form of laser therapy for patients with glaucoma
Presented as an alternative to filtering surgery for patients whose open angle glaucoma was not controlled by meds
Exact mechanism of effect is unknown but:
- Mechanical effects from laser burns scarring tissue and causing contracting of tissue and opening of adjacent areas of the TM
- Biologic effects with increased inflammatory cells with "clean up" the TM

ALT complications/risks
1. IOP spike/elevation
   - Most often transient
   - High risk pt – may consider Diamox
2. Inflammation
   - Pred Forte QID X 1 week
   - Use appropriate laser energy
3. Peripheral Anterior Synechie (PAS)
   - As the scar tissue forms from the laser PAS can form
   - May increase IOP long-term

Patient Pre-op Drops
- 1 drop Alphagan or Iopidine 15-30 minutes prior to
- 1 drop pilocarpine 1% (optional)

Laser Settings
- Energy 600 mW
- Spot Size 50 microns
- Duration 0.1 sec
- Pulses 1 (shoots once every time you push the foot pedal)

Focus on the anterior aspect of the pigmented TM*****
- Aim is much more critical with ALT than SLT
- Adjust Energy as needed
  - Pigment blanching
  - Small bubble formation
- Treat inferior 180 degrees first
- Space burns approximately 2 spot sizes apart
  - 45-60 burns per 180 degrees

Post-op Care
- 1 drop of Alphagan or Iopidine
- Check IOP 15-30 minutes after the procedure
- Continue all glaucoma meds
- Pred Forte QID X 1 week
- RTC 1-2 weeks for f/u
ALT Post-operative Period

- 1-2 week post-op exam:
  - Check IOP
  - Check for A/C reaction
  - Should be minimal to no C&F

- 6 week post-op exam:
  - Check IOP
  - Start to consider reducing glaucoma meds if pressure is reduced
  - May consider treating superior 180 degrees

Argon Laser Trabeculoplasty (ALT)

- Long term outcome:
  - 80% effective at 1 year
  - 50% effective at 5 years
  - 30% effective at 10 years

- Retreatments:
  - Success rate is much lower
  - More likely to get complications
  - 50% of retreatments require filtering procedure within 6 months to lower IOP

Selective Laser Trabeculoplasty (SLT)

- Newer form of laser therapy for patients with glaucoma
- Presented as an alternative to filtering surgery for patients whose open angle glaucoma was not controlled by meds
- Exact mechanism of effect is unknown but:
  - Biologic effects with increased inflammatory cells with “clean up” the TM
  - Laser energy causes chemical mediators to attracts macrophages and phagocytes to come and clean up the debris in the TM

ALT Procedure/SLT Procedure

Scanning electron microscopy comparison of TM after ALT above and SLT below

Selective Laser Trabeculoplasty (SLT)

- Optimal laser is a Q-switched frequency doubled 532 nm Nd:YAG Laser (Lumenis, formerly Coherent, Selecta II Glaucoma Laser System)
- Permits selective targeting of pigmented TM cells w/o causing structurally or coagulative damage to the TM
SLT works on the principle of Thermalysis which involves the Thermal Relaxation Time:
- The time required by melanin granules to convert electromagnetic energy into thermal energy.
- Melanin has a TRT = 1 microsecond.
- SLT has a pulse duration = 3 nanoseconds.
- Since pulse duration is so quick, melanin cannot convert the laser electromagnetic energy into thermal energy.
  - No thermal damage ("cold laser").

**SLT Med Study (2012)**
- Dr. Katz @ Wills Eye in Philadelphia
  - J Glaucoma 2012;21:460-468
- SLT (100 applications over 360 degrees of TM) vs. prostaglandin analog
- Primary outcome -> IOP
- Secondary outcome -> # of treatment steps

**Results:**
1. 29 SLT patients -> IOP reduced from 24.5 to 18.2 (6.3 mmHg reduction)
2. 25 prostaglandin patients -> IOP reduced from 24.7 to 17.7 (7.0 mmHg reduction)
3. SLT group -> 11% of eyes required additional SLT
4. Prostaglandin group -> 27% of eyes required additional medication
SLT as Primary Therapy

- IOP decreased by 30% (7.7 mmHg), from 25.5 to 17.9 mmHg over the f/u period
- Forte eyes (89%) had a decrease of 5 mmHg or more

"Selective laser trabeculoplasty is effective and safe as a primary treatment for patients with ocular hypertension and open-angle glaucoma."

[Graph showing 30% IOP reduction]

Dr. Lawrence Jindra, M.D.
Clinical Professor of Ophthalmology, Columbia University, New York

- Retrospective review of 1,983 eyes in which SLT was used as primary and secondary treatment
- Criteria for success:
  - Decrease in IOP and subsequent maintenance below the goal IOP w/o addition of meds, repeat SLT, or surgery

For Primary Treatment:
- 97% at 1 year
- 92% at 5 years
- 90% at years 7-10

For Secondary Treatment:
- 80%

Selective Laser Trabeculoplasty (SLT)

- SLT complications/risks
  1. IOP spike/elevation
     - Most often transient
     - High risk pt – may consider Diamox
  2. Inflammation
     - Anti-inflammatory
     - Use appropriate laser energy
  3. Stromal haze/edema
     - Rare - usually responds to a topical steroid
  4. Peripheral Anterior Synechie (PAS)
     - Less likely due to less/no scar tissue formation
     - May increase IOP long-term

SLT Procedure

- Patient Pre-op Drops
  - 1 drop Alphagan or Iopidine 15-30 minutes prior to
  - 1 drop pilocarpine 1% (optional)

- Laser Settings
  - Energy 0.6 – 1.2 mJ (0.8 – 1.0 mJ most often used)
  - Spot Size 400 microns
  - Duration 3 nsec
  - Pulses 1 (shoots once every time you push the foot pedal)

- Sit patient comfortably
- Adjust laser for your comfort
- Armrest, oculars, controls, safety glasses
- Instill proparacaine in both eyes
- Place laser lens on eye with goniosol or celluvisc
- Gonio mirror usually at 3:00 or 9:00
- Treat 360 degrees in both eyes unless significant pigment in the TM
The Latina SLT Gonio Laser Lens was designed specifically for Selective Laser Trabeculoplasty. 1.0x magnification maintains laser spot size and 1 to 1 laser energy delivery. Tilted anterior lens surface corrects astigmatism to maintain circular laser beam profile and give sharp images for examination. Suitable for standard laser trabeculoplasty.

**Spot Size Comparison**

ALT on the left  SLT on the right

**SLT Procedure**

- Large spot size – cover the entire TM
  - Aim is less critical with SLT compared to ALT
  - Easier to do**
- Adjust Energy as needed (start around 0.8 mJ)
  - Usually don’t want to see pigment blanching w/ SLT
  - Small bubble formation
- Treat 360 degrees in both eyes unless significant pigment in the TM
- Space burns right next to each other
  - 45-60 burns per 180 degrees

**SLT Post-operative Period**

- Post-op Care
  - 1 drop of Alphagan or Iopidine
  - Check IOP 15-30 minutes after the procedure
  - Continue all glaucoma meds
  - Give pt post-op med(s)
  - RTC 1-2 weeks for f/u
- 1-2 week post-op exam:
  - Check IOP
  - Check for A/C reaction
    - Should be minimal to no C&F
- 6 week post-op exam:
  - Check IOP
  - Start to consider reducing glaucoma meds if pressure is reduced
  - May consider treating superior 180 degrees
Selective Laser Trabeculoplasty (SLT)

- Long term outcome
  - 80% effective at 1 year
  - 50% effective at 5 years
  - 30% effective at 10 years
- Tends to be very effective for 12-36 months
  - Effect perhaps wanes after that

Retreatments
- Since no mechanical damage -> can we repeat SLT???

SLT Enhancement & Repeatability
- SLT Enhancement: Treating previously untreated area (27 eyes)
- Repeatability: Re-treating previously treated area (15 eyes)
- Retrospective analysis of case notes
- Average SLT Life
  - After enhancement: 18.26 months
  - After repeat treatment: 17.47 months
- SLT enhancement success rate
  - One year: 70.37%
  - Two years: 55.55%
  - Three years: 25.93%
- SLT repeat treatment success rate
  - One year: 70.37%
  - Two years: 53.33%

Repeatability of 360° SLT in OAG
- 52 Eyes with successful IOP reduction for at least one year
  - Pretreatment IOP: 21.1 mmHg
  - Post-treatment IOP at one year: 17.0 mm Hg
  - IOP reduction of 4.1 mmHg
- Retreated with 360° SLT
  - IOP reduction of re-treated eyes: 3.6 mm Hg

Selective Laser Trabeculoplasty (SLT)

- Retreatments
  - Since no mechanical damage -> can repeat SLT
  - How many times do we repeat it?
    - Usually twice

ALT & SLT Summary

- Positives
  - Work about 80-95% of the time
  - On average, takes the place of 1 medication
    - ALT & SLT average IOP reduction of 20-35%
    - ALT 20-25% reduction
    - SLT 20-35% reduction as primary therapy
    - SLT 21-25% reduction as secondary therapy
    - Doesn’t interfere with other treatments or meds

- Negatives
  - Effect tends to diminish over time
  - ALT has more side effects and fails more often as time goes by than SLT
Comparison of ALT & SLT

<table>
<thead>
<tr>
<th></th>
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<th>SLT</th>
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<tbody>
<tr>
<td>Laser Used</td>
<td>Argon</td>
<td>Q-switched frequency doubled YAG laser</td>
</tr>
<tr>
<td>No of laser shots/180°</td>
<td>45-60</td>
<td>45-60</td>
</tr>
<tr>
<td>Energy</td>
<td>400-600 mW</td>
<td>0.8-1.4 mJ</td>
</tr>
<tr>
<td>Fluence (mJ/mm²)</td>
<td>40,000</td>
<td>6</td>
</tr>
<tr>
<td>Spot Size</td>
<td>50 microns</td>
<td>400 microns</td>
</tr>
<tr>
<td>Duration of laser shot</td>
<td>0.1 seconds</td>
<td>3 nsec</td>
</tr>
<tr>
<td>Mechanism of Action</td>
<td>Mechanical</td>
<td>Biological</td>
</tr>
<tr>
<td>IOP Reduction</td>
<td>20-30%</td>
<td>20-30%</td>
</tr>
<tr>
<td>Repeatable?</td>
<td>No</td>
<td>Yes</td>
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ALT & SLT Summary

- Code for ALT & SLT is the same
  - 69855
- How much do we get paid?
  - $308.98/eye
  - If you do them on the same day
    - 100% of the first eye
    - 50% of the second eye
- Global Period is the same as well
  - 10 global period
  - Contrast that to YAG cap & laser PI
    - 90 days
- Patients aged 65 years or more
- Source: Ontario Health Insurance Plan
- Medication Therapy Groups:
  - Monotherapy
  - Bi-drug Therapy
  - Tri-drug Therapy
- Cost of SLT Analysis Scenarios
  - SLT Effective for 2 years
  - SLT Effective for 3 years
- Repeatability of SLT was assumed


Projected Cost Comparison for POAG Primary SLT vs. Medications

- Patients aged 65 years or more
- Source: Ontario Health Insurance Plan
- Medication Therapy Groups:
  - Monotherapy
  - Bi-drug Therapy
  - Tri-drug Therapy
- Cost of SLT Analysis Scenarios
  - SLT Effective for 2 years
  - SLT Effective for 3 years
- Repeatability of SLT was assumed


ALT & SLT Summary

- Positives
  - Work about 80-95% of the time
  - On average, takes the place of 1 medication
    - ALT & SLT average IOP reduction of 20-35%
      - ALT 20-25% reduction
      - SLT 21-25% reduction as primary therapy
      - SLT 21-25% reduction as secondary therapy
  - Doesn’t interfere with other treatments or meds
  - Cost beneficial as well??
- Negatives
  - Effect tends to diminish over time
  - ALT has more side effects and fails more often as time goes by than SLT

Thank You!
Please Don’t Take the Clickers.
Lighthiz@nsuok.edu