

## Laser Procedures for the Management of Glaucoma and More

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## 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)
- Other Laser Trabeculoplasty

## 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

## 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

## YAG Laser

- 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\*

### YAG Cap Pre-op Exam

- 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 Risks, Complications, Contraindications

#### Contraindications

1. Corneal problems
2. Intraocular inflammation
3. Macular problems
4. Patient unable to hold steady or fixate

#### Risks/complications

1. IOP spike/elevation
  - Most often transient
2. Inflammation
  - Pred Forte QID X 1 week
  - Use appropriate laser energy
3. Floaters
4. Retinal detachment
5. Permanent vision loss

### 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

- 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

### 1 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 \$243.98
- 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

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  - 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 Indications

- Primary angle closure
- Plateau iris syndrome/configuration
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## 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

### Contraindications

1. Corneal problems
2. Intraocular inflammation
3. Iris in contact with endo
4. Angle closure from NVG or inflammatory glaucoma
5. Patient unable to hold steady or fixate
6. Macular problems?

### Risks/complications

1. Non-perforation
2. IOP spike/elevation
  - Most often transient
3. Inflammation
  - Pred Forte QID X 1 week
  - Use appropriate laser energy
- Others: hyphema, synechiae, peaked pupil, floaters, blur, monocular diplopia, RD, permanent vision loss

## PI Procedure

- Patient Pre-op Drops
  - 1 drop Pilocarpine 1% or 2% OU
  - 1 drop Alphagan or lolidine OU
- Laser Settings
  - Depends on which laser you use

## PI Laser Options

### Argon laser

- Less commonly used
- Advantages:
  - Less bleeding
  - Less debris
- Disadvantages:
  - Less successful compared to YAG laser in penetration
    - Requires more shots
- 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
  - 11:00 or 1:00
- Place Abraham Iridotomy laser lens on eye with goniosol or cellulisc
  - Orientation of lens matters
  - Button @ 11 or 1 o'clock (for a superior PI)

### PI Procedure

- 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”

### PI Procedure

- Often times it takes 2 visits to finish PI
  - 70-80% through the first visit
  - 150-250 mJ maximum energy for me on 1 visit
- Goals:
  - patent PI  $\approx$  1mm in size
  - Deepening of the AC
  - IOP control

### PI Procedure

- 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

### 1 week post-operative exam

- VA's
- Anterior segment exam
  - Check for cell/flare
  - Note AC depth
  - Is the PI patent?
- Gonio – did angle deepen?
- Check IOP
- D/C Pred Forte
- Release back to referring doc

### Peripheral Iridotomy (PI)

- Reimbursement codes
  - 66761 \$222.05
- 10 day global period

### Why do we need lasers?

- 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

### Laser Trabeculoplasty (LTP)

- Glaucoma Laser Trial (1990)
  - Compared ALT to topical meds in the control of IOP and VF and ONH status
  - Results:
    - Pts who underwent ALT as first-line therapy achieved better control of IOP and better VF and ONH status than those treated initially with topical meds
    - 44% proper IOP control in the ALT group
    - 30% proper IOP control in the meds group
    - Fewer eyes that underwent ALT as first-line therapy ultimately required 2 or more meds postoperatively to control IOP

### LTP Indications

- POAG
- Normo-tensive glaucoma
- Pigmentary dispersion glaucoma
- Pseudoexfoliative 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

### Argon Laser Trabeculoplasty (ALT)

- 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

## Argon Laser Trabeculoplasty (ALT)

- 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

## ALT Procedure

- Patient Pre-op Drops
  - 1 drop Alphagan or lopicidine 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)

## ALT Procedure

- 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

## ALT Post-operative Period

- Post-op Care
  - 1 drop of Alphagan or lopicidine
  - 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 attract macrophages and phagocytes to come and clean up the debris in the TM

### 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

### Thermal Relaxation Time

- 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”)

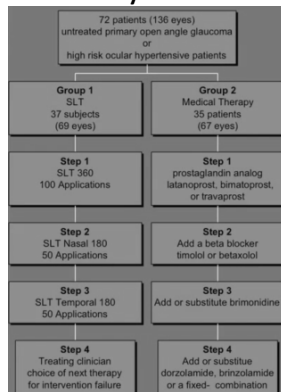
### Selective Laser Trabeculoplasty Versus Medical Therapy as Initial Treatment of Glaucoma: A Prospective, Randomized Trial

*L. Jay Katz, MD,\* William C. Steinmann, MD,† Azad Kabir, MD,‡ Jeanne Molineaux, COA,\* Sheryl S. Wizov, COA,\* and George Marcellino, PhD§ the SLT/Med Study Group*

*J Glaucoma • Volume 21, Number 7, September 2012*

- 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

### SLT Med Study Treatment Arms



### SLT vs. Prostaglandins

- SLT Med Study (2012)
  - Results:**
    1. 29 SLT patients -> IOP reduced from 24.5 to 18.2 (6.3 mmHg reduction)
    - 25 prostaglandin patients -> IOP reduced from 24.7 to 17.7 (7.0 mmHg reduction)
  - 2. SLT group -> 11% of eyes required additional SLT
  - Prostaglandin group -> 27% of eyes required additional medication

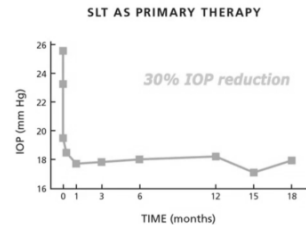


## SLT Med Study

**Conclusions:** IOP reduction was similar in both arms after 9 to 12-months follow-up. More treatment steps were necessary to maintain target IOP in the medication group, although there was not a statistically significant difference between groups. These results support the option of SLT as a safe and effective initial therapy in open-angle glaucoma or ocular hypertension.

## SLT as Primary Therapy

- IOP decreased by 30% (7.7 mmHg), from 25.5 to 17.9 mmHg over the f/u period
- Forty 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.”

Arch Ophthalmol. 2003;121: 957-960

## Dr. Lawrence Jindra, M.D.

Winthrop University Hospital  
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%

## Dr. Lawrence Jindra, M.D.

Winthrop University Hospital  
Clinical Professor of Ophthalmology, Columbia University, New York

- “Given the amount of data and experience on SLT, we believe that prescribing medications instead of SLT for primary treatment of glaucoma today is analogous to performing intracapsular cataract extraction rather than phacoemulsification. It can be done, but why would you?”

## Selective Laser Trabeculoplasty (SLT)

- SLT complications/risks
  1. IOP spike/elevation
    - 3-5% risk
    - Most often transient
  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)

### SLT Procedure

- 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

### Latina SLT Gonio Lens

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.

### 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 lopicidine
  - 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

### SLT 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???

### 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

## Selective Laser Trabeculoplasty (SLT)

- 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%

Nagar M, Shah N, Vadav R: AAO Poster, Las Vegas 2006

## 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

Bournias TE, Lai J: AAO Paper, Las Vegas 2006

## 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 28-35% 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

## ALT & SLT Summary

- Code for ALT & SLT is the same
  - 65855
- How much do we get paid?
  - \$244.78/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

### 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

Lee R, Hutnik CM: Can J Ophthalmol. 2006 Aug;41(4):449-56

### Projected Cost Comparison for POAG Primary SLT vs. Medications

- 6 year cost comparison
  - a. SLT Effective for 2 years
    - Monotherapy: \$206.54
    - Bi-therapy: \$1,668.84
    - Tri-drug therapy: \$2,992.67
  - b. SLT Effective for 3 years
    - Monotherapy: \$580.52
    - Bi-therapy: \$2,042.82
    - Tri-therapy: \$3,366.65

Lee R, Hutnik CM: Can J Ophthalmol. 2006 Aug;41(4):449-56

## ALT & SLT Summary

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    - ALT & SLT average IOP reduction of 20-35%
      - ALT 20-25% reduction
      - SLT 28-35% reduction as primary therapy
      - SLT 21-25% reduction as secondary therapy
  - Doesn't interfere with other treatments or meds
  - **Cost benefit?**
- Negatives
  - Effect tends to diminish over time
  - ALT has more side effects and fails more often as time goes by than SLT

## Low Power SLT???

- Gandolfi, Stephen M.D.
  - University of Pami, Italy
- ARVO 2014
  - 1. SLT low power yearly
  - 2. SLT normal power as needed
  - 3. ALT 1 treatment
- 46 low power SLT (0.4 mJ, 40-50 shots over 360)
- 37 normal power SLT (0.8-1.0 mJ, 80 shots over 360)
- 39 ALT (500-800 watts, 80 shots over 360)

## Low Power SLT???

- Gandolfi, Stephen M.D.
  - University of Pami, Italy
- F/U was 5-7 years
- Ocular HTN patients that did not need meds:
  - 85% vs. 47% vs. 38%
- Mean time to initiation of medical therapy:
  - 6.2 vs. 3.3 vs. 3.5