SLT For Open Angle Glaucoma
Aaron McNulty, OD, FAAO
Louisville Eye Center
Louisville, KY

Disclosures
Nothing to disclose

Course Outline
- Trabeculoplasty overview
- Indications
- Contraindications
- Outcomes
  - Predicting SLT Success
- Special considerations
- Preoperative preparation
- Procedure technique
- Postoperative management
- Risks and complications
- Emerging technologies

Trabeculoplasty: An Overview
- Argon (ALT) and Selective (SLT)
- Laser treatment of the trabecular meshwork to enhance aqueous outflow

When is Laser Useful?
- Often secondary line of treatment, but some use as primary
- Max meds and need for more IOP reduction
- Patient has trouble instilling drops
- Patient noncompliant with drops
- Patient doesn’t want to use drops every day
- Concern about diurnal control
- Doctor preference
Over 90% admitted to missing some drops!

**History of laser trabeculoplasty**
- Modern ALT based on 1979 report by Wise and Witter
- SLT introduced in 1998 by Latina
- FDA approved in 2001
- Mechanism of action of both remains controversial

**Argon Laser Trabeculoplasty (ALT)**
- Pigment dependent laser
- Photocoagulative effect
- Exact mechanism of action unknown
  - Laser may photocoagulate TM, leading to scarring and tissue contraction
  - Leads to opening of channels through TM for aqueous outflow
  - Biological activation of macrophages may help "clean up" TM

**Selective Laser Trabeculoplasty (SLT)**
- Frequency doubled, Q-switched Nd:YAG
- Wavelength output is 532nm green
- Burn time is 3 nanoseconds
  - Why is this important?

**SLT proposed mechanism**
- Thermal relaxation time
  - Amount of time it takes melanin to convert light energy into heat
  - 1 microsecond
- SLT pulse duration is 3 nanoseconds
- No thermal damage ("cold laser")
- Targets intracellular melanin
- No effect on adjacent non-melanin containing cells ("selective")
SLT proposed mechanism (cont)

- Target cells activate cytokines, which activate macrophages
- Macrophages clean area, decreasing outflow resistance
- No mechanical damage/scars (unlike ALT)
  - Potentially repeatable
- Recent research: also improves uveoscleral outflow

Trabeculoplasty indications

- POAG
- OHTN
- Normal tension glaucoma
- Pigment dispersion glaucoma
- Pseudoexfoliative glaucoma

Glaucoma Laser Trial (GLT) (1990)

- ALT (360°) was as effective as medication (timolol monotherapy) for newly diagnosed POAG
- Through 7 years of follow up
  - Equal IOP lowering to timolol
  - Better optic disc/visual field status

Use of Trabeculoplasty in the US

SLT/Med Study

- Published 2012
- Prospective randomized clinical trial
- 100 eyes followed for 1 year
- POAG and OHTN
- Randomized to SLT or prostaglandin
- If target IOP not met:
  - Repeated SLT in laser group
  - Added drops in medication group

TM after ALT/SLT

- TM after ALT burn placement
- TM after SLT burn placement
**SLT/Med Study**
- Baseline IOP ~24.5 in both groups
- IOP reduction
  - SLT: 6.3mmHg
  - Meds: 7.0mmHg
- Need for additional treatment
  - SLT: 11%
  - Meds: 27%
- Conclusion: SLT is a viable first line treatment for POAG

**SLT as first line?**
- American Academy of Ophthalmology Preferred Practice Patterns
  - “Laser trabeculoplasty can be considered as initial therapy in selected patients.”

**SLT as first line?**
- UpToDate
  - “Once the decision has been made to treat a patient with open-angle glaucoma, we recommend pharmacologic or laser therapy as first line treatment.”
  - Grade 1B evidence

**SLT as first line?**
- 2015 Meta-Analysis (Oi Man Wong et. al)
  - “Robust evidence that SLT may be...offered as a primary treatment to patients with OAG.”

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**Trabeculoplasty contraindications**
- Angle closure glaucoma and emergency IOP lowering
- Narrow angle glaucoma (if unable to see TM)
- Inflammatory glaucoma
- Neovascular glaucoma
- Hazy media
- Relative contraindications
  - Angle recession
  - Age under 40

**Trabeculoplasty efficacy**
- Expected IOP reduction: 20-30%
- 80-90% effective at one year
- 30-50% effective at five years
Predicting SLT Success

- SLT is not 100% effective
- Modest response in some
- What if we could predict nonresponders?

Predicting SLT Success

Development of a Prediction Rule to Estimate the Probability of Acceptable Intracocular Pressure Reduction After Selective Laser Trabeculoplasty in Open-angle Glaucoma and Ocular Hypertension

Alexander J. Mon, MD, OI, MPH* Xueying Pan, MD† Ian McTernan, MD* Maurice Strossfeld, MD*, George Crystal, MD,* and Cindy Hirsh, MD*

- Looked at:
  ○ Pre-treatment IOP, current medications, phakic status, level of pigmentation, steroid use, age, gender

SLT and prostaglandins (PGA)

- SLT may function similarly to PGA
  ○ Low-grade inflammation
- 2007 study: In patients on drops, SLT had the least impact in eyes already treated with PGA

SLT and prostaglandins (PGA)

- Alvarado et. al
- Two parts to study
  ○ In vitro
    ■ PGA and trabeculoplasty have competitive mechanism of action
  ○ Clinical arm

Alvarado et. al Clinical Arm

- 24 patients
- Withdrew PGA for washout period, then did SLT
- Measured SLT response after 90 days
Alvarado et. al Clinical Arm

- Average IOP reduction
  - PGA: 25%
  - SLT: 30%
- PGA responders tended to be SLT responders (at equivalent levels)

Alvarado et. al Proposed Protocol

- If patient is on no glaucoma meds preoperatively
  - Test response with PGA
  - If successful, proceed with SLT
  - SLT functions like starting PGA
- If patient is already on PGA preoperatively
  - Discontinue PGA for 1 month
  - If IOP increases, expect SLT to work
  - SLT basically replaces PGA

Alvarado et. al Proposed Protocol

- If patient needs further IOP reduction following SLT, consider using non-PGA medication

Trabeculoplasty Diurnal Control

- How effective is SLT at controlling nocturnal IOP spikes?

Prospective study: 18 patients on drops undergoing ALT
- Subjects stayed in sleep lab
- Checked IOP during day (sitting) and overnight (supine)
  - Repeated before and after ALT
Trabeculoplasty Diurnal Control

- Mean nocturnal IOP was 1.8mmHg lower after ALT
  - Some patients showed no improvement during day, but still had blunted nocturnal spike

SLT and normal tension glaucoma (NTG)

- How much IOP reduction can we expect?
- Does improved diurnal control still apply?

SLT and normal tension glaucoma (NTG)

- 14-16% IOP reduction
  - 2015 meta-analysis of SLT studies
  - Diurnal control benefits
    - 2014 study: SLT decreases nocturnal spikes in NTG patients

SLT and pigment dispersion

- Is it effective?
- Is it safe?

Expected SLT outcome:
- IOP 16 → 14
- Blunted nocturnal spikes
SLT and pigment dispersion

- SLT mechanism of action
- Thermal relaxation time

SLT tends to be very effective, HOWEVER...

- 2005 paper reported four cases of PDG with severe IOP spike following SLT
  - Required urgent trabeculectomy
- Some doctors avoid SLT in PDG

SLT and pigment dispersion

- Consider “test dose”: 10 shots at 0.3mJ
- If no IOP spike, proceed with treating one quadrant at a time
  - Monitor IOP response after each quadrant
  - May not need to treat all four quadrants

Preoperative preparation

- Basic exam components
  - VA, IOP, slit lamp, etc
- Gonioscopy
  - Open angle?
  - Assess pigmentation
  - Rule out angle recession, peripheral anterior synecchia, NVG

Laser Lenses

- Latina lens
  - 1x magnification
- Ritch lens
  - 1.4x magnification
  - Reduces spot size by 30% and increases laser power by 2x
  - Must account for this in laser settings!

Preoperative preparation

- Informed consent
  - Risks, benefits, alternatives
- Blood pressure/pulse
- One drop brimonidine or apraclonidine
- Pilocarpine 1% if needed to open angle and better visualize TM
- Proparacaine OU immediately before laser lens insertion
**Laser settings**

<table>
<thead>
<tr>
<th></th>
<th>ALT</th>
<th>SLT</th>
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<tbody>
<tr>
<td>Power</td>
<td>600mW</td>
<td>0.6-1.2mW</td>
</tr>
<tr>
<td>Spot size</td>
<td>50 microns</td>
<td>400 microns</td>
</tr>
<tr>
<td>Pulse duration</td>
<td>0.1 second</td>
<td>3 nanoseconds</td>
</tr>
</tbody>
</table>

**Laser preparation**
- Adjust patient height for comfort
- Adjust table and laser for your comfort
- Configure elbow rest and oculars

**Procedure Technique**
- Insert laser lens with cushioning solution
- Visualize angle
- Establish a consistent approach that you follow every time
  - i.e. start at 9:00 and go clockwise
  - Identify a landmark before rotating lens
ALT technique
- Focus on anterior TM
  - Aim is critical
- 50 micron spot size
- Place burns two spot sizes apart
- 50 burns per 180°
- Look for slight pigment blanching and bubble formation
  - Adjust energy as needed

SLT technique
- Treatment spot covers entire TM
  - Easier to aim than ALT
  - 400 micron spot size
- Place spots next to each other
- Initial power 0.8-1.0mJ
  - 0.5-0.6 for heavy pigment (PDG)
  - Titrate by 0.1mJ increments
  - Want bubbles every ~3 pulses
  - No tissue blanching or other visible response
  - May need more energy in superior angle
- 50 spots per 180°

ALT vs SLT spot size
- ALT 50 microns
- SLT 400 microns

ALT vs SLT

<table>
<thead>
<tr>
<th></th>
<th>ALT</th>
<th>SLT</th>
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</thead>
<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>
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<tr>
<td>Energy</td>
<td>400-460 mW</td>
<td>0.5-1.4 mJ</td>
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<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 msec</td>
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<tr>
<td>Mechanism of Action</td>
<td>Mechanical</td>
<td>Biological</td>
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<tr>
<td>IOP Reduction</td>
<td>20-30%</td>
<td>20-30%</td>
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<tr>
<td>Repeatable?</td>
<td>No</td>
<td>Yes</td>
</tr>
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</table>
Postoperative management

- Remove lens, rinse eye with saline
- One drop brimonidine or apraclonidine
- Check IOP 30 min-1 hour later
- Continue all glaucoma meds
- Rx postop drops
  - ALT: Prednisolone acetate QID x 1 week
  - SLT: Topical NSAID TID x 3-4 days

Postoperative management

- ALT works by mechanically altering TM structure
  - Prednisolone prevents excessive inflammation
- SLT works by activating macrophages to "clean up" TM
  - Controlled inflammatory response is needed for SLT
  - NSAID prn, may discourage if no ache

One week postoperative visit

- IOP check
  - No expected effect yet
- Check for iritis/inflammation
  - Expect minimal/no reaction
- Gonioscopy for peripheral anterior synechiae
- Discontinue anti-inflammatory drops
- Return 5-7 weeks for 6-8 week postop

Two month postoperative visit

- Evaluate IOP response
- If good response, treat other eye
  - Consider stopping/changing medications
- May see response in fellow eye due to systemic activation of macrophages

Repeat treatments

- Is SLT repeatable?
- Are repeat treatments as effective as the first?

Repeat treatments

- SLT is widely considered to be repeatable
  - No mechanical damage to TM
  - Largely based on anecdotal evidence and small studies
  - Repeat treatments may be less effective and may not last as long
- ALT is not repeatable
2011 multicenter retrospective study
- 137 eyes
- 6 months to 8 years between first and second SLT
First SLT
  - 20.3mmHg → 16.3mmHg
Second SLT
  - 19.4mmHg → 16.3mmHg

Complications
- IOP spike
  - Generally 24 hours or less
  - 5-25%
- Mild inflammatory response
  - 50% or more
  - Quiet by 1 week
  - Watch laser power setting
- Peripheral anterior synechiae
  - May be more common in ALT (promotes scarring)

SLT following other surgeries
- SLT after failed trabeculectomy
  - AGIS: ~30% success rate
  - Higher risk of hyphema?
- SLT after iridotomy
  - Often only do 180°
    - Heavy pigment in angle

SLT and MIGS
- MIGS: Minimally/micro-invasive glaucoma surgery
- SLT is likely safer
  - "I see SLT as something to do before the patient has to go to the operating room. I think SLT is the safest thing I do in glaucoma care...Many patients should have SLT first...If the patient ends up needing to go to the OR, adding a MIGS procedure might be sufficient."
- MIGS may be stronger
  - SLT enhances trabecular meshwork, MIGS bypass trabecular meshwork completely
**SLT and MIGS**

- MIGS procedures may be combined with cataract surgery
- 2013 study: SLT following failed Trabectome
  - All 14 SLTs failed

**SLT Learning Curve**

- Gonioscopy is best practice
- 2014 study compared SLT performed by attending physicians to those performed by first year ophthalmology residents (doing their first SLT)
  - 110 procedures
  - Supervised by an attending surgeon
  - Comparable results between residents' first SLT and attending surgeons
  - IOP reduction and safety profile

**SLT Pearls**

- Clearing the view with a hazy cornea
- Accommodating prominent brows
- Patient perception of laser procedures

**Micropulse-diode laser trabeculoplasty (mDLT)**

- Delivers small, repetitive micropulses rather than one continuous pulse
  - Cooling periods between micropulses reduces tissue damage

**Novel SLT approaches**

- Annual low-power SLT for OHTN
  - 2014 ARVO paper
  - 0.4mJ; 40-50 spots over 360 degrees
  - Repeated yearly, regardless of IOP level
  - Followed 3-10 years
  - Mean treated IOP similar to traditional SLT
  - Fewer patients needed medications to control IOP vs traditional SLT

- Trans-scleral approach
  - 2014 ARVO paper
  - SLT applied to sclera overlying TM
  - IOP reduction equivalent to traditional SLT
Reimbursement
- CPT 65855 (both SLT and ALT)
- $276/eye (Medicare)
  - $242 in facility
- 50% for second eye if same day
- 10 day global period

Questions?
Thank you!
mcnulty.aaron@gmail.com

Evidence based medicine and trabeculoplasty
- Level I (strongest) evidence: Long-term efficacy of initial ALT for OAG compared to medical therapy
- Level II: Efficacy of SLT for lowering IOP
- Level III: Repeat use of SLT
- Further research needed: Superiority of ALT/SLT, repeatability, treatment techniques

Video examples