Glaucoma Laser Technology

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Disclosures

• The presenter has no financial interest in any of the products or companies mentioned in this lecture.

Lasers

• Light Amplification by Stimulated Emission of Radiation

• Monochromatic light with high power density is able to cause significant tissue reaction

• Lasers can be continuous wave, long pulse, or Q-switched.

Common Therapeutic Anterior Segment Lasers

• Ruby
• Helium-Neon (He-Ne)
• Neodymium: YAG
• Holmium
• Argon
• CO₂
• Excimer

Laser Classes

• Class 1 – Under normal operating conditions, these lasers do not emit a hazardous amount of light (<0.39μW)

• Class 2 – These lasers emit visible wavelengths for exposures shorter than the eye aversion response time.

• Class 3
  – a – emit less than 5mW. Accidental exposure may be ok, but overall direct viewing of the beam is not recommended
  – b – these will lead to injury if viewed directly or by reflection

• Class 4 – can cause ocular injury not only by direct or specular exposure, but also by diffuse reflection.
Lasers in Glaucoma Therapy

- Open angle laser treatments
  - Argon Laser Trabeculoplasty
  - Selective Laser Trabeculoplasty

- Angle closure laser treatments
  - Peripheral Iridotomy
  - Argon Laser Peripheral Iridoplasty

Gonioscopy

- Gonioscopy Videos

- Good website to review technique and pathologies
  - www.gonioscopy.org

Open Angle Glaucoma

Argon Laser Trabeculoplasty

- In 1973, Worthen and Wickham described using a laser to perform trabeculoplasty.
- Krasnov, at the same time described performing a goniopuncture or laseropuncture using a Q-switched ruby laser.
- It was not until 1979 that Wise and Witter described Argon Laser Trabeculoplasty (ALT)

How it works

- Exact mechanism remains unclear
  - Tightening of the TM
  - Induces mitosis of trabeculocytes
  - Alteration of the glucosaminoglycans
- Whatever the mechanism, ALT will improve outflow.

When to use ALT

- Glaucoma Laser Trabeculoplasty Study
  - One eye was treated with ALT and the other received medical treatment.
  - No significant difference between the two groups, slightly less trabs and VF loss in ALT group.
- Advanced Glaucoma Intervention Study
  - Compared filtering surgery to ALT.
  - Maybe better VF outcome in AA when ALT used first.
When to use ALT

- Good option for patients when compliance is an issue.
- Good option for patients who have a difficult time getting in drops.
- When IOP slightly to moderately (3-4 mmHg) above target levels on maximal medical therapy.

When Not to use ALT

- Angle Closure/ Narrow Angle
- Uveitic Glaucoma or Ocular Inflammation
- Congenital Glaucoma
- Neovascular glaucoma
- Angle Recession (relative)
- Glaucoma Suspect (relative)
- Emergency IOP reduction needed
- Prior complications
- Greater than 30 IOPs (relative) – 6-10mm drop expected (AGIS)
- Under 40 yrs old, except pigmentary glaucoma. (AGIS)

Factors improving Success

- Type of glaucoma
  - Pigmentary
  - POAG
  - PXE
  - Glaucoma pseudophakia
    - Only if no vitreous in the Anterior chamber
- Trabecular pigmentation
- No history of ocular inflammation
- Age greater than 40

Procedure - Tools

- Topical anesthetic
- Apraclonidine hydrochloride 1% or brimonidine tartrate 0.2%
- Pilocarpine hydrochloride 1%
- Goniosol
- Laser gonio lens
- Argon laser
- Topical corticosteroid

ALT Preoperative

- 1 drop of apraclonidine or brimonidine to reduce IOP spikes.
- 1 drop of pilocarpine 1% to improve visibility of angle structures.
- Lavage any NaFl in the eye – will absorb and scatter Argon laser.

ALT Procedure

- Spot size: 50 microns / 180 degrees
- Pulse duration: 0.1 seconds
- Power: 600-700 mW initially

Remember: use the least energy that still gives desired result

- Ideal tissue reaction is slight blanching with minimal bubble formation

**ALT Procedure**

- Initial treatment – 180 degrees starting at 6 o’clock.
- Some will treat 360 degrees – may increase complications.
- With 180 degree treatment, considered treating remaining TM at 6 week visit.

**ALT complications**

- Common
  - Transient IOP spike (usually resolves within 24-72hrs)
  - Uveitis
  - PAS
- Uncommon
  - Permanent IOP spike (3%)
  - Trabeculitis
  - Hyphema
  - Corneal Burn
  - Retinal Detachment

**ALT Post Op**

- Post procedure – 1 drop apraclonidine
- 1 hr – IOP check
- 1 day – IOP check
- 1 week – gonio and IOP check
- 4-6 weeks – gonio and IOP check
- Patient uses topical corticosteroids q2h X 1 day and QID till 1 week visit.

**What Patients Experience**

- Very rarely do patients report pain.
- Some patients will report slight discomfort.
- Patients do report seeing the flashes from the laser.

Figure from: Alward WL. A History of Gonioscopy. Optometry and Vision Science. Jan 2011; 88(1), 1-7
ALT Outcomes

• ~ 25% IOP reduction in ~75% of patients
• Better success in eyes with greater pigmentation.
• Has a half life of ~5 yrs
• Has minimal affect on topical medical therapy and success of future interventions.

Selective Laser Trabeculoplasty

• SLT approved in 2001 – so limited long term data available.
• Used a frequency doubled Q-switched Nd:YAG laser with fixed duration of 3 ns.
• Spot size is fixed at 400 µm.

SLT - procedure

• Pre op is the same as that for ALT
• Energy is set at 1 mJ and titrated accordingly.
• Spots are centered on the TM avoiding schwabbe’s line.
• Ideal tissue reaction - trace blanching and ‘champagne’ bubbles.

SLT Procedure

SLT Post Op

• Post procedure – 1 drop apraclonidine
• 1 hr – IOP check
• 1 day – IOP check
• 1 week – gonio and IOP check
• 4-6 weeks – gonio and IOP check
• Patient uses topical NSAID as needed up to three times a day.

SLT - complications

• Only seen in 4.5% of cases.
• Delivery only 0.01% of energy that ALT does
• Most common complications include
  – Transient IOP spike
  – Anterior chamber inflammation
SLT

- Up to 35% reduction in IOP in 95% of cases when used as primary therapy.
- Up to 25% reduction in IOP in 75% of cases when used in addition to topical medications.
- Can be done over ALT. Different mechanism
  - Selective absorption by only pigmented cells
  - Stimulation of chemotactic and vasoactive agents and recruitment of macrophages.

SLT vs. ALT

Selective Laser Trabeculoplasty (SLT) versus Argon Laser Trabeculoplasty (ALT): A Prospective, Randomized Clinical Trial.

<table>
<thead>
<tr>
<th>Mean IOP (mm Hg)</th>
<th>ALT</th>
<th>SLT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>22.5</td>
<td>22.8</td>
</tr>
<tr>
<td>1 month</td>
<td>19.5</td>
<td>20.1</td>
</tr>
<tr>
<td>6 months</td>
<td>17.7</td>
<td>17.8</td>
</tr>
</tbody>
</table>

LT Coding

- 65855 – laser trabeculoplasty treatment series.
- Reimbursement ~ $293.86

Closed Angle Glaucoma

Peripheral Iridotomy
Argon Laser Iridoplasty

Peripheral Iridotomy

- Most common method used in treating both primary and secondary angle closure glaucomas.
Peripheral Iridotomy - Evaluation

• Important to perform gonioscopy with room light reduced.
• Recommended to use small square beam to prevent pupil constriction.
• Gonioscopy should be performed with minimal pressure or indentation of the cornea.
• Indentation gonioscopy should be performed to identify any PAS

Procedure - Tools

• Topical anesthetic
• Apraclonidine hydrochloride 1% or brimonidine tartrate 0.2%
• Pilocarpine hydrochloride 1%
• Goniosol
• Laser lens (optional)
• Nd:YAG and/or Argon laser
• Topical corticosteroid

PI Contraindications

• Corneal non-transparency
• Iris in contact with endothelium
• Multiple failed iridotomies
• Angle Closure Secondary to Neovascular or inflammatory glaucomas
• Cannot bring patient to the slit lamp, and/or patient has tremors

PI Precautions

• ASA
• Lid Position
• Shallow Anterior Chamber
• Corneal status
• Uveitis and CME history
• Glaucoma status
• Monocularity/Nystagmus

PI Alternatives

• Surgical iridectomy
  – Equal results to laser PI
  – Increased risk
  • Intraocular heme
  • Infection
  • Malignant glaucoma

• If concurrent surgery not occurring, choose laser PI

Preoperative

• Informed consent
• 1 drop apraclonidine
• 1 drop pilocarpine 1%
• 1 drop of corticosteroid (optional)

• Wait 30 minutes prior to procedure
• Lavage eye if NaFl was used.
PI Laser Selection

- Nd:YAG
  - Penetration rate 95%
  - Lower rates of iridotomy closure
  - Photodisruption (non-pigment dependant)
  - Initial energy 1.5 to 2.0 mJ
    - Least energy with successful interaction max of ~6mJ
  - Focus carefully (remember laser offset)
  - Increased risk of bleeding
  - More likely to be hindered by debris

- Argon
  - 80% success (more difficult to penetrate thick irides)
  - Higher rates of iridotomy closure
  - Pigment dependant
  - Spot size 50um, Duration 0.1sec, 600-1200mW
  - Less bleeding and debris issues
  - Requires more shots than YAG
  - Argon pre-treat before YAG had advantages

PI Complications

- Transient blur
- Uveitis
- IOP Spike
- Hyphema – from 35 to 50% of cases
- Synechia formation
- Others: Monocular diplopia, Peaked pupil, Corneal/lens/retina damage, RD, CME

PI Post op

- Pred Forte 1% - Q2hrs to 4 times a day
- Iopidine 1% - 1 drop post op
- Continue all glaucoma medications – caution with prostaglandins
- Follow patient 1 week, 1 month, 3 months
- Check for patency at each visit – look for zonules and lens epithelium

PI Coding

- 66761– Iridotomy/iridectomy by laser surgery, per session.
- Reimbursement ~ $270.09

Argon Laser Peripheral Iridoplasty (ALPI)

- ALPI can be used in instances when a laser iridotomy cannot be used or has not been successful.
ALPI - Indications

- Useful when:
  - Shallow anterior chambers
  - Individuals have marked inflammation
  - Unresponsive to patent PI
  - Moderate corneal edema –can still view iris
- Can be useful for
  - Chronic angle closure
  - Plateau iris syndrome
  - Angle closure related to lens
- Can be performed prior to laser trabeculoplasty
- When possible, a PI should be performed

ALPI – contraindications

- Significant corneal edema
- Flat anterior chamber with iris endothelial contact
- Synechial angle closure
- Neovascular glaucoma

ALPI - preoperative

- Informed consent
- 1 drop apraclonidine
- 1 drop pilocarpine 1% (do not use for maintenance)
- 1 drop of corticosteroid (optional)
- Wait 30 minutes prior to procedure
- Lavage eye if NaFl was used.

ALPI Procedure

- Use a laser contact lens
- Spot size 500 um
- Duration 0.5 seconds
- Power: 200-400 mW
- Place 20-30 spots in far peripheral iris – 6 shots per quadrant
- Repeat IOP and vitals following treatment. Also repeat gonio post procedure

ALPI complications

- Spike in IOP
- Uveitis
- Corneal burns
- Iris necrosis
- Iris atrophy

ALPI Postoperative

- 1 drop of apraclonidine
- 1 drop of corticosteroid
- Measure IOP in 2-3 hours
- Recheck with gonioscopy in 2-3 hours
- Patient to use topical corticosteroids 4-6 times a day for a week
- Follow up 1 day, 1 week, 1 month
ALPI

- Used many times after PI placed
- May be used when PI prohibited
- Very useful for breaking otherwise unresponsive attacks
- Response in 2-3 hours
- Increases safety and success of future PI or cataract extraction by reducing inflammation

ALPI Coding

- 66762 – Iridoplasty by photocoagulation (1 or more sessions).
- Reimbursement ~ $409.64

Questions

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