Glaucoma Laser Therapy Update

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Disclosures

Instructors have no relevant financial relationships to disclose.

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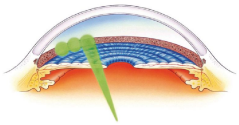
Trabeculoplasty: An Overview

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



When is Laser Useful?

- Primary therapy vs adjunct?
- 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

Am J Ophthalmol. 2005 Oct;140(4):598-606.

Persistence and adherence with topical glaucoma therapy.

Nordstrom BL, Friedman DS, Mozaffari E, Quigley HA, Walker AM.
Ingenix Epidemiology, Auburndale, Massachusetts 02466, USA. bnordstrom@epidemiology.com

Abstract

PURPOSE: The present study describes the patterns and predictors of treatment persistence and adherence among patients who are diagnosed with glaucoma or as glaucoma suspects (based on claims codes).

DESIGN: A retrospective cohort study using health insurance claims data.

METHODS: Newly treated individuals with diagnosed glaucoma (n = 3623) and suspect glaucoma (n = 1677) were obtained from healthcare claims data in the Ingenix Research Database. For each of these two diagnostic groups, we calculated the duration of continuous treatment with the initially prescribed medication (persistence) and the prevalence of use of the initial medication at various time points (adherence). Four drug classes were included: beta-blockers, alpha-agonists, carbonic anhydrase inhibitors, and prostaglandin analogs.

RESULTS: Nearly one half of the individuals who had filled a glaucoma prescription discontinued all topical ocular hypotensive therapy within six months, and just 37% of these individuals recently had refilled their initial medication at three years after the first dispensing. Prostaglandins were associated with better persistence than any other drug class, which was indicated by hazard ratios for discontinuation of prostaglandins compared with beta-blockers of 0.40 (95% confidence interval, 0.35-0.44) for diagnosed patients and 0.44 (95% confidence interval, 0.37-0.52) for patients with suspect glaucoma. Prostaglandins showed a similar advantage in adherence. Furthermore, patients with diagnosed glaucoma were more likely to adhere to therapy than patients with suspect glaucoma (relative risk = 1.11; 95% confidence interval, 1.05-1.18).

CONCLUSION: Persistence and adherence were substantially better with prostaglandins than with other drug classes, and patients with diagnosed open-angle glaucoma were more likely to adhere to treatment than suspected glaucoma.

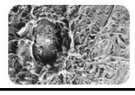
Over 90% admitted to missing some drops!

History of laser trabeculoplasty

- Modern ALT based on 1979 report by Wise and Witter
- SLT introduced in 1998 by Latina
  - First FDA approval 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

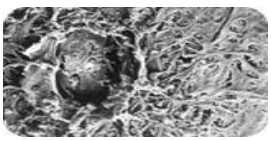
- Thermal relaxation time
  - Amount of time it takes melanin to convert light energy into heat
  - 1 microsecond
- SLT pulse duration is 3 nanoseconds
- No thermal damage (“cold laser”)
- Targets intracellular melanin
- No effect on adjacent non-melanin containing cells (“selective”)

SLT proposed mechanism (cont)

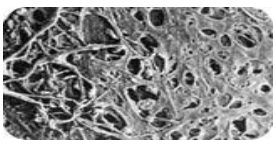
- Target cells activate cytokines, which activate macrophages
- Macrophages clean area, decreasing outflow resistance
- No mechanical damage/scars (unlike ALT)
  - Potentially repeatable

- Recent research: also improves uveoscleral outflow

TM after ALT/SLT



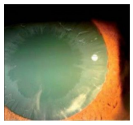
TM after ALT burn placement



TM after SLT burn placement

Trabeculoplasty indications

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



Glaucoma Laser Trial (GLT) (1990)

- ALT (360º) 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

SLT/Med Study

- POAG and OHTN
- Randomized to SLT or prostaglandin
- No difference in IOP reduction or need for additional treatment

- 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

UpToDate
Providing Answers to Clinical Questions

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."
- 2020 Meta-Analysis (Chu Chi et. al)
  - "Our analysis suggests that SLT may be a first-line therapy in OAG."

SLT as first line?

Selective laser trabeculoplasty versus eye drops for first-line treatment of ocular hypertension and glaucoma (LiGHT): a multicentre randomised controlled trial

*Gus Gazzard, Evgenia Konstantakopoulou, David Garway-Heath, Anurag Garg, Victoria Vickerstaff, Rachael Hunter, Gareth Ambler, Catey Bunce, Richard Wormald, Neil Nathwani, Keith Barton, Gary Rubin, Marta Buszewicz, on behalf of the LiGHT Trial Study Group**

- RCT with n=718
- Followed for 3 years
- Looked at QoL, efficacy, cost, and safety

Selective laser trabeculoplasty versus eye drops for first-line treatment of ocular hypertension and glaucoma (LiGHT): a multicentre randomised controlled trial

*Gus Gazzard, Evgenia Konstantakopoulou, David Garway-Heath, Anurag Garg, Victoria Vickerstaff, Rachael Hunter, Gareth Ambler, Catey Bunce, Richard Wormald, Neil Nathwani, Keith Barton, Gary Rubin, Marta Buszewicz, on behalf of the LiGHT Trial Study Group**

- "Selective laser trabeculoplasty provides superior intraocular pressure stability to drops, at a lower cost and, importantly, it allows almost three quarters of patients (74%) to be successfully controlled without drops for at least 3 years after starting treatment."

LiGHT Study: Additional conclusions

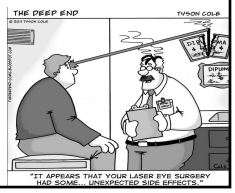
- Initial med treatment group:
  - Slightly higher rate of rapid VF progression
  - More need for incisional surgery
  - Drop adherence was not measured

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?

Factors Associated With Favorable Laser Trabeculoplasty Response: IRIS Registry Analysis

TA C. CHANG, RICHARD K. PARRISH, DANIELLE FUJINO, SCOTT P. KELLY, AND ELIZABETH A. VANNER

IRIS Registry Analysis (2021)

- "Responders": At least 20% IOP reduction after 8 weeks
- "Nonresponders": Less than 20% IOP reduction after 8 weeks

IRIS Registry Analysis (2021)

- High baseline IOP predicts response
- Angle recession, uveitis, aphakia decrease response

IRIS Registry Analysis (2021)

- Overall response rate 37%
- Among baseline IOP over 24mmHg: 69% response rate
  - Mean baseline IOP 19.1mmHg
  - These providers are offering SLT with low IOP, despite evidence that SLT is most effective with high IOP

IRIS Registry Analysis (2021)

- Nonresponders with at least 1 medication at baseline: 76% had fewer medications after SLT
- Basically replaces medications in this case

AMERICAN ACADEMY OF OPHTHALMOLOGY®

Real-World Outcomes of Selective Laser Trabeculoplasty in the United Kingdom

Anthony P. Khawaja, PhD, FRCOphth,[1] Joanna H. Campbell, PhD,[2] Nicholas Kirby, BSc,[3] Hatesh S. Chandwani, MBBS, PhD,[4] Ian Keyzor, MSc,[5] Mousam Parekh, MS,[6] Andrew I. McNaught, MD,[7,8] for the UK Glaucoma Real-World Data Consortium

- The major baseline factor associated with SLT success was pre-SLT IOP
  - At low IOP, resistance to outflow may be affected by non-TM pathway including Schlemm's canal and episcleral venous pressure

- No association between concurrent glaucoma medication use and treatment success
  - Includes PGA use
- "Our study is strongly powered for examining this association and suggests that SLT is a reasonable treatment option even in patients already using drops"

ORIGINAL STUDY

Predictors of Success in Selective Laser Trabeculoplasty: Data From the Lausanne Laser Trabeculoplasty Registry

Sina Elahi, MD, Harsha L. Rao, MD, PhD,† Alina Dumitru, MD,* and Kaweh Mansouri, MD, MPH*,‡*

	Univariate Analysis			Multivariate Analysis		
	OR	CI	*P*	OR	CI	*P*
Qualified success						
Age*				0.99	0.96-1.03	0.76
Sex (male)*				2.79	1.17-6.68	0.02
Pseudophakia*				0.60	0.23-1.57	0.30
Cup:disc ratio*				0.29	0.03-2.47	0.26
Baseline IOP*				1.15	1.04-1.25	< 0.01
Presence of treatment pre-SLT*				2.57	1.10-6.05	0.03
Baseline MD†	0.97	0.91-1.07	0.74			
Baseline RNFL†	1.02	0.99-1.05	0.24			
OHT diagnosis†	1.29	0.59-2.83	0.53			
POAG diagnosis†	0.75	0.36-1.58	0.45			
PEXG diagnosis†	1.20	0.34-4.17	0.77			
Impact number*				1.01	0.99-1.04	0.29
Total energy†	1.00	0.98-1.03	0.65			
Complete success						
Age*				1.01	0.98-1.04	0.49
Sex (male)*				1.37	0.69-2.74	0.37
Pseudophakia*				0.63	0.28-1.40	0.26
Cup:disc ratio*				1.13	0.18-6.97	0.90
Baseline IOP*				1.27	1.15-1.40	<0.01
Presence of treatment pre-SLT*				0.61	0.28-1.32	0.21
Baseline MD†	0.95	0.89-1.03	0.21			
Baseline RNFL†	1.00	0.98-1.02	0.86			
OHT diagnosis†	1.37	0.68-2.76	0.38			
POAG diagnosis†	0.93	0.47-1.84	0.84			
PEXG diagnosis†	0.84	0.27-2.58	0.76			
Impact number*				1.01	0.99-1.04	0.22
Total energy†	1.02	1.00-1.04	0.04			

Predictive Factors for Outcomes of Selective Laser Trabeculoplasty

Matthew Hirabayashi[1,2], Vikram Ponnusamy[3] & Jella An[1,2]✉

	Values		*p*-value	
	2 month	6 month	2 month	6 month
Age (years), mean ± SD			0.540	0.869
Success	70.8 ± 11.9	70.8 ± 11.5		
Failure	69.3 ± 10.3	69.2 ± 10.4		
Type (successful cases)			0.248	0.074
POAG, n (%)	63/76 (82.9)	79/97 (81.4)		
NTG, n (%)	9/76 (11.8)	13/97 (13.4)		
SOAG, n (%)	4/76 (5.3)	5/97 (5.2)		
Severity (successful cases)			0.588	0.311
Mild, *n* (%)	32/76 (42.1)	41/97 (42.3)		
Moderate, n (%)	14/76 (18.4)	18/97 (18.5)		
Severe, n (%)	30/76 (39.5)	38/97 (39.2)		
TM Pigmentation (successful cases)*			0.494	0.134
Light, n (%)	61/74 (82.4)	76/92 (82.6)		
Heavy, n (%)	13/74 (17.6)	16/92 (17.4)		
Total Energy Delivery (mJ), mean ± SD			0.325	0.989
Success	61.4 ± 26.7	64.2 ± 24.5		
Failure	62.1 ± 22.8	59.7 ± 24.2		
Baseline IOP (successful cases)			*<0.001**	*<0.001**
>18 mmHg, n (%)	56/76 (73.7)	75/97 (77.3)		
≤18 mmHg, n (%)	20/76 (26.3)	22/97 (22.7)		

Predicting SLT Success

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

Alexander J. Mao, MD, OD, MPH, Xiao-jing Pan, MD,† Ian McIlraith, MD,* Maurice Strasfeld, MD,* George Colev, MD,* and Cindy Hutnik, MD**

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

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

Published in final edited form as:
J Glaucoma. 2018 October ; 27(10): 845–848. doi:10.1097/IJG.0000000000001018.

West Indies Glaucoma Laser Study (WIGLS): 2. Predictors of Selective Laser Trabeculoplasty Efficacy in Afro-Caribbeans with Glaucoma

Tony Realini[1], **Hazel Shillingford-Ricketts**[2], **Darra Burt**[3], and **Goundappa K. Balasubramani**[4]

Table 2

Bivariate analysis of putative predictive factors for 12-month response (percent intraocular pressure reduction) to selective laser trabeculoplasty in the West Indies Glaucoma Laser Study.

Variables	Right eye		Left eye	
	Estimate (SE)	p value	Estimate (SE)	p value
Baseline IOP (per mmHg)	0.62 (0.49)	0.211	0.58 (0.45)	0.193
Age (per year)	-0.202 (0.14)	0.137	-0.22 (0.12)	0.059
Gender (ref: female)	-6.16 (3.05)	**0.045**	-7.24 (2.52)	**0.004**
Site (ref: Dominica)	-3.61 (3.20)	0.262	-3.19 (2.74)	0.246
Time (ref: Month 12)				
Month 3	9.38 (2.32)		10.84 (2.20)	
Month 6	8.46 (2.35)	**0.0004**	6.79 (2.22)	**<.0001**
Month 9	6.72 (2.37)		5.82 (2.24)	
Number of IOP lowering Medications (ref: 0)				
1	-0.79 (5.78)		-0.25 (5.47)	
2	-2.96 (6.32)	0.764	-4.01 (5.90)	0.419
3	4.53 (8.42)		5.55 (7.59)	
Central Corneal Thickness (per micron)	-0.08 (0.04)	0.083	-0.08 (0.04)	**0.027**
Vertical cup-disc ratio (per 1.0 unit)	22.12 (10.93)	**0.044**	24.45 (11.83)	**0.040**
Visual field mean deviation (per dB)	0.13 (0.31)	0.682	-0.29 (0.34)	0.400
Visual field pattern standard deviation (per dB)	-0.18 (0.55)	0.743	0.55 (0.54)	0.308
Prior use of Prostaglandin therapy (ref: no)	-7.39 (2.37)	**0.014**	-3.60 (2.62)	0.170
Total laser energy (per mJ)	0.005(0.076)	0.259	0.096(0.064)	0.137

TM Pigment and Success

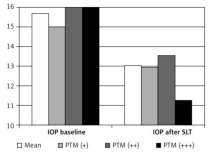


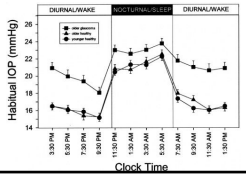
Figure 1. IOP reduction 6 weeks after selective laser trabeculoplasty (in mm Hg) depending on angle pigmentation (PTM)

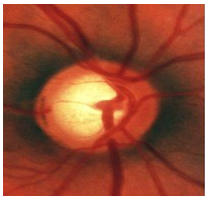
Table I. Mean IOP reduction in the examined subgroups

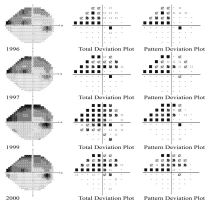
PTM +	(*n* = 17) 13.7%	15.0–12.94 mm Hg
PTM ++	(*n* = 37) 15.3%	16.0–13.54 mm Hg
PTM +++	(*n* = 8) 29.6%	16.0–11.25 mm Hg

Trabeculoplasty Diurnal Control

- How effective is SLT at controlling nocturnal IOP spikes?







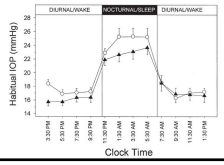
Trabeculoplasty Diurnal Control

- 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

Enrollment Order	Prostaglandin Analogs[4]	β-Adrenergic Antagonists[1]	Carbonic Anhydrase Inhibitors[2]	α_2-Adrenergic Agonist[3]
1	×			
2		×		
3	×	×	×	×
4		×		
5	×	×	×	
6	×	×	×	×
7	×		×	×
8	×	×		×
9	×	×	×	
10	×	×	×	×
11	×			
12	×	×		×
13	×			
14	×			
15	×	×	×	
16	×	×		
17	×	×	×	×
18	×	×	×	×

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)

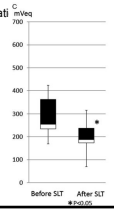
- How much IOP reduction can we expect?
- Does improved diurnal control still apply?

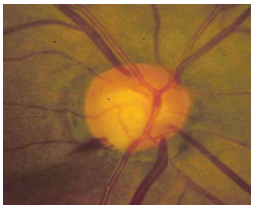
Figure 1. Percentage Probability of Success with SLT[4]

Pre-laser IOP (mmHg)	Maximum Recorded IOP in Previous Visits (mmHg)														
	20	22	24	26	28	30	32	34	36	38	40	42	44	48	50
14	29	26	20	20	17	15	13	11	9	8	7	6	5	3	3
16	40	36	30	28	25	22	19	16	14	12	10	9	8	5	5
18	51	47	40	39	35	31	27	24	21	18	16	13	12	8	7
20	63	59	50	50	46	42	37	33	30	26	23	20	17	13	11
22	73	69	70	62	57	53	49	44	40	36	32	29	25	19	17
24	81	78	80	72	68	64	60	56	52	48	43	39	35	27	24
26	87	85	80	80	78	74	71	67	63	59	55	51	46	38	34
28	92	90	90	87	85	82	80	77	73	70	66	62	58	49	45
30	95	94	90	91	90	88	86	84	82	79	76	72	69	61	57
32	97	96	100	94	93	92	91	89	88	86	83	81	78	71	68
34	98	97	100	96	96	95	94	93	92	90	89	87	85	80	77
36	99	98	100	98	97	97	96	96	95	94	93	91	90	86	84
38	99	99	100	99	98	98	98	97	97	96	95	94	94	91	90
40	99	99	100	99	99	99	98	98	98	97	97	96	96	94	93

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 pati





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

ORIGINAL ARTICLE

Clinical & Experimental Ophthalmology WILEY

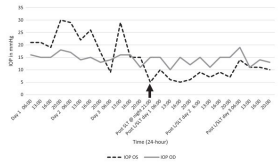
Using Icare HOME tonometry for follow-up of patients with open-angle glaucoma before and after selective laser trabeculoplasty

Mona S. Awadalla MBBS PhD | Ayub Qassim MBBS | Mark Hassall MBBS PhD | Thi T. Nguyen BMSc MOptom | John Landers FRANZCO PhD | Jamie E. Craig FRANZCO PhD

TABLE 2 Preoperative and postoperative IOP data

	Pre-SLT	Post-SLT	*P* value
Mean IOP	17.6 (3.79)	12.5 (4.20)	<.001
Maximum IOP	26.3 (6.58)	20.1 (8.54)	<.001
IOP fluctuation	4.35 (1.26)	3.29 (1.61)	<.05

Note: Values represent the mean (SD).

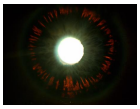
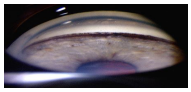


iCare study: Conclusions

- Significant IOP reduction at 1 week
- Reduction in IOP fluctuation

SLT and pigment dispersion

- Is it effective?
- Is it safe?

SLT and pigment dispersion

- SLT mechanism of action
- Thermal relaxation time

SLT and pigment dispersion

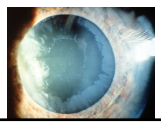
- SLT tends to be very effective, HOWEVER...
- 2005 paper reported four cases of PDG with severe IOP spike following SLT
  - Required urgent trabeculectomy
- Some doctors avoid SLT in PDG

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

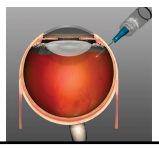
SLT and Pseudoexfoliation

- Heavy pigmentation → Good response
- Wears off more quickly
- Higher risk (similar to PDG)
  - 2016 case series of 5 patients with persistent IOP spikes needing incisional surgery
- Recommended for mild/moderate cases

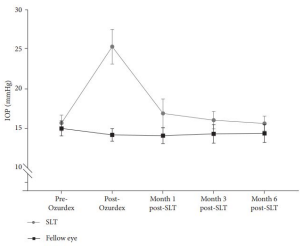


SLT for Steroid-Induced Glaucoma

- Effective in cases of intravitreal triamcinolone and intravitreal dexamethasone implant
- Sometimes advocated prophylactically before intravitreal injection, especially if OHTN



SLT after Dexamethasone Implant



Preoperative preparation

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

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 Lenses

- Latina lens
  - 1x magnification
- Ritch lens
  - 1.4x magnification
  - Reduces spot size and increases laser power
  - Alter laser settings!
- Volk Rapid SLT Lens
  - 4 mirrors

Laser settings

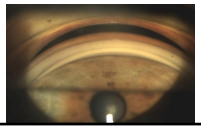
	ALT	SLT
Power	600mW	0.6-1.2mW
Spot size	50 microns	400 microns
Pulse duration	0.1 second	3 nanoseconds

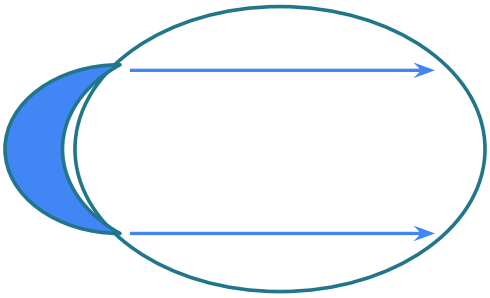
Laser preparation

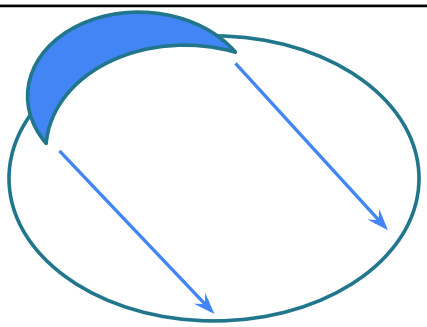
- Adjust patient height for comfort
- Adjust table and laser for your comfort
- Configure elbow rest and oculars

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



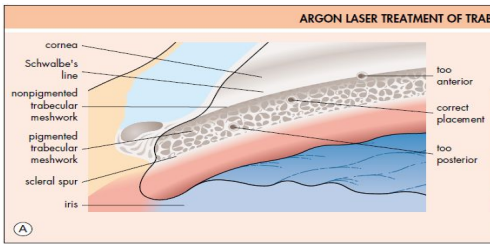




ALT technique

- Focus on anterior TM
  - Aim is critical
- 50 micron spot size
- Place burns two spot sizes apart
- 50 burns per 180º
- Look for slight pigment blanching and bubble formation
  - Adjust energy as needed

ALT technique



SLT technique

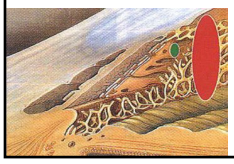
- Treatment spot covers entire TM
  - Easier to aim than ALT
  - 400 micron spot size
- Place spots next to each other
- Initial power 0.8-1.0mJ
  - 0.5mJ for heavy pigment (PDG)
  - Titrate by 0.1mJ increments
    - Want bubbles every 1-3 pulses (none in PDG)
    - No tissue blanching or other visible response
  - May need more energy in superior angle
- 50 spots per 180º

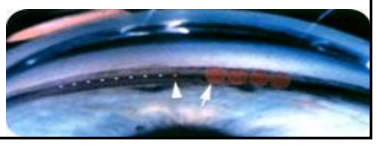
SLT technique

- 360º treatment generally considered standard
  - Literature is fairly inconclusive
  - Strongly consider a "trial run" in PDG eyes
    - 90-180° at a time
    - Excess pigment → extra inflammatory response
    - IOP spike more likely
    - Rule of thumb: More pigment, less energy

ALT vs SLT spot size

- ALT 50 microns
- SLT 400 microns





ALT vs SLT

	ALT	SLT
Laser Used	Argon	Q-switched frequency doubled YAG laser
No of laser shots/180^0	45-60	45-60
Energy	400-600 mW	0.8-1.4 mJ
Fluence (mJ/mm^2)	40,000	6
Spot Size	50 microns	400 microns
Duration of laser shot	0.1 seconds	3 nsec
Mechanism of Action	Mechanical	Biological
IOP Reduction	20-30%	20-30%
Repeatable?	No	Yes

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

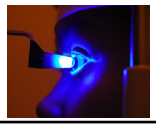
- ALT works by mechanically altering TM structure
  - Prednisolone prevents excessive inflammation
- SLT works by activating macrophages to “clean up” TM
  - Controlled inflammatory response is needed for SLT
  - NSAID prn, may discourage if no ache

One week postoperative visit

- IOP check
  - Full effect not yet expected
- 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

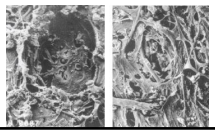


Repeat treatments

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

Repeat treatments

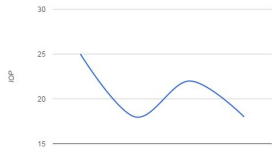
- SLT is widely considered to be repeatable
  - No mechanical damage to TM
  - Largely based on anecdotal evidence and small studies
  - Repeat treatments may be less effective and may not last as long
- ALT is not repeatable



Repeat treatments

- 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

Repeat treatments



Repeat treatments

Table 1 Summary of conducted studies regarding SLT repeatability.

Paper	Year	Diagnosis	Number of eyes (n)	Number of patients (n)	Conclusion
Hong *et al.* (11)	2009	POAG, PXG and PG	44	35	The repeat 360° SLT performed 6 months after the successful initial 360 SLT may be safe and effective
Avery *et al.* (12)	2013	POAG	42	42	Similar efficacy was found in primary SLT and repeat SLT in treatment of POAG. Repeat SLT produces a longer effective duration
Khouri *et al.* (13)	2014	POAG, PXG and PG	51	34	Equal proportion of eyes responds successfully to repeat SLT regardless of the initial SLT effect was successful or modest
Ayala *et al.* (14)	2014	POAG and PXG	80	80	Repeat SLT on the same trabecular meshwork area has same effect as on two different areas
Khouri *et al.* (15)	2014	POAG, PXG and PG	45	25	Repeat SLT is effective in controlling IOP up to 2 years
Polat *et al.* (16)	2016	POAG, PXG and PG	38	38	IOP in open-angle glaucoma can be controlled with repeat SLT which achieves comparable result as successful initial SLT
Francis *et al.* (17)	2016	POAG, PXG, PG, OHT and JOAG	137	137	Both initial SLT and repeat SLT with 360-degree treatment lowers IOP similarly
Durr *et al.* (18)	2016	POAG, PXG and NTG	38	38	The second SLT resulted in similar IOP lowering effect as previous 360° SLT with possibly more sustained response

"If primary SLT is unsuccessful, or its effects subside, repeat SLT, with comparable efficacy and low complication rates, should be encouraged"

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Efficacy of Repeat Selective Laser Trabeculoplasty in Medication-Naive Open-Angle Glaucoma and Ocular Hypertension during the LiGHT Trial

LiGHT retreatment data

- Looked at patients requiring retreatment within 18 months
- Retreatment triggered by failure to hit individualized target IOP and/or disease progression
- 115 eyes met these criteria

LiGHT repeat SLT data

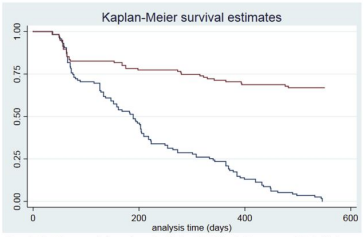


Figure 2. Kaplan–Meier plot for 115 eyes: initial selective laser trabeculoplasty (SLT) (**blue line**) versus repeat SLT (**red line**).

LiGHT repeat SLT: Conclusions

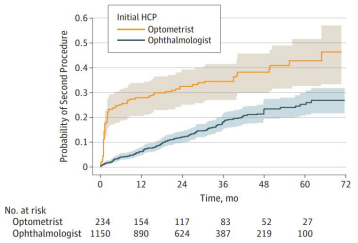
- "After repeat SLT, the cumulative effect of initial and repeat SLT may provide an equivalent and possibly longer duration of clinical benefit than after initial SLT alone."
- "Repeat SLT is safe, with minimal laser-related side effects seen during the LiGHT trial."

JAMA Ophthalmology | Original Investigation

Comparison of Outcomes of Laser Trabeculoplasty Performed by Optometrists vs Ophthalmologists in Oklahoma

Joshua D. Stein, MD, MS; Peter Y. Zhao, MD; Chris Andrews, PhD; Gregory L. Skuta, MD

Figure 2. Time to Second Laser Trabeculoplasty in Same Eye for Beneficiaries Receiving Initial Treatment by Ophthalmologists and Optometrists



Comparisons of outcomes by ODs and OMDs

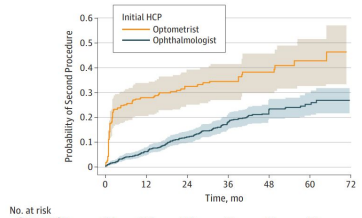
- OD patients were ~2x more likely to receive additional SLT in the same eye
- "Based on the findings of these analyses, we urge state legislatures and health policy makers to be cautious about giving optometrists privileges to perform LTP in other states until additional research is done"

Comment by Murray Fingeret, Brooklyn, NY, USA

69903 Comparison of Outcomes of Laser Trabeculoplasty Performed by Optometrists vs Ophthalmologists in Oklahoma; Stein JD, Zhao PY, Andrews C, Skuta GL; JAMA ophthalmology 2016; 134: 1095-1101

- "During the study period, Oklahoma ODs were trained to perform LTPs in split sessions, as suggested in peer-reviewed papers of the period"

Figure 2. Time to Second Laser Trabeculoplasty in Same Eye for Beneficiaries Receiving Initial Treatment by Ophthalmologists and Optometrists



No. at risk

Optometrist	234	154	117	83	52	27
Ophthalmologist	1150	890	624	387	219	100

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)
  - 2015 meta-analysis: ~3%
- Cystoid macular edema (rare)

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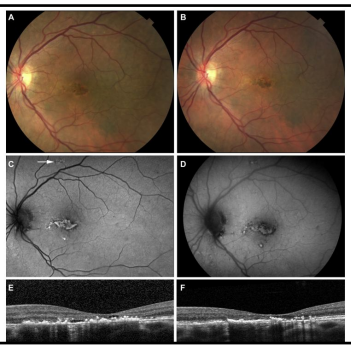
Reports

Dual-mode Capsulotomy and Selective Laser Trabeculoplasty Lasers Continue to Cause Severe, Permanent Macular Injuries

- Case report of a 65-year-old woman complaining of severe vision loss after a failed capsulotomy one week prior
- She was informed that the laser procedure could not be performed in her left eye because of "laser focusing problems"



What happened?

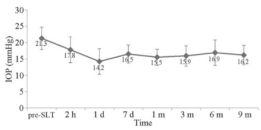
- "Severe macular injuries after inadvertent attempts to use and SLT laser beam to perform capsulotomy"

Who is to blame?

- "Administrative controls were absent or ignored. Laser safety officials at any facility with a capsulotomy- SLT laser system should be aware of its potential misuse"
- "Engineering controls to prevent improper laser mode selection were also inadequate"

SLT following other surgeries

- SLT after failed trabeculectomy
  - AGIS: ~30% success rate
    - Higher risk of hyphema?
  - More recent studies suggest better success

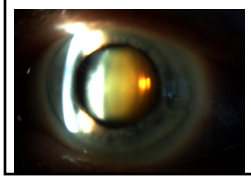


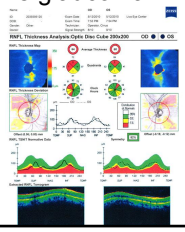
SLT following other surgeries

- SLT after iridotomy
  - Recent studies support SLT if at least 180º open
    - 2018 study: 87% successful at 1 yr (20% reduction)
  - Often only do 180º
    - Heavy pigment in angle
  - PGA may be more effective

SLT and MIGS

- MIGS: Minimally/micro-invasive glaucoma surgery





SLT and MIGS

- 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."
    - Robert Noecker, MD, Review of Ophthalmology 2014
- MIGS may be stronger
  - SLT enhances trabecular meshwork, MIGS bypass trabecular meshwork completely

Clinical & Experimental Ophthalmology
Clinical and Experimental Ophthalmology 2017; 45: 120–127 doi: 10.1111/ceo.12805

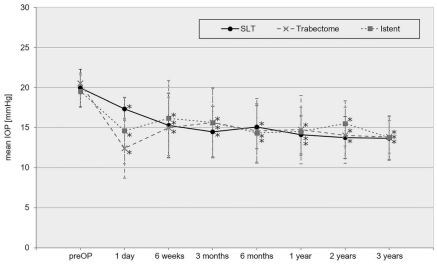
Original Article

Hydrus microstent compared to selective laser trabeculoplasty in primary open angle glaucoma: one year results

ORIGINAL RESEARCH

Selective Laser Trabeculoplasty Versus MIGS: Forgotten Art or First-Step Procedure in Selected Patients with Open-Angle Glaucoma

Milena Pahlitzsch · Anja-Maria Davids · Sibylle Winterhalter · Malte Zorn · Emanuel Reitemeyer · Matthias K. J. Klamann · Necip Torun · Eckart Bertelmann · Anna-Karina Maier



- "As 'magic dwells in each beginning', new procedures might detract from the effectiveness and safety of methods like SLT, which then become neglected."
- They advocate SLT first, followed by MIGS as needed

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 Learning Curve

Acta Ophthalmologica
Acta Ophthalmologica 2019

Evaluation of selective laser trabeculoplasty as an intraocular pressure lowering option

SLT Learning Curve

- Residents vs “less experienced specialists” vs “senior specialists”
- Residents = specialists
- Residents & specialists < senior specialists
- Senior specialists: More spots, more energy, more success
  - No mention of complications
- Conclusion: “The data would suggest that experience is not the deciding factor in terms of outcome and IOP reduction.”

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Real-World Outcomes of Selective Laser Trabeculoplasty in the United Kingdom

Anthony P. Khawaja, PhD, FRCOphth,[1] Joanna H. Campbell, PhD,[2] Nicholas Kirby, BSc,[3] Hatesh S. Chandwani, MBBS, PhD,[4] Ian Keyzor, MSc,[5] Mousam Parekh, MS,[6] Andrew J. McNaught, MD,[7,8] for the UK Glaucoma Real-World Data Consortium

- Better outcomes with trainees compared to their consultants
- They assume the more difficult cases were done by consultants
- “Certainly, our data do not suggest an increased chance of success with more experienced laser operators"

Factors Associated With Favorable Laser Trabeculoplasty Response: IRIS Registry Analysis

TA C. CHANG, RICHARD K. PARRISH, DANIELLE FUJINO, SCOTT P. KELLY, AND ELIZABETH A. VANNER

- No difference in outcomes:
  - Glaucoma specialists, nonglaucoma anterior segment surgens, and “others”
  - Varying number of LTP performed in the 12 months preceding the study
- “Technical demands of LTP are modest.”

ORIGINAL ARTICLE

Laser Trabeculoplasty Perceptions and Practice Patterns of Canadian Ophthalmologists

Elizabeth Y Lee[1], Forough Farrokhyar[2], Enitan Sogbesan[3]

Where does the initial LTP fall the most in your glaucoma treatment algorithm?	124
First-line treatment of glaucoma	22 (17.7)
Concurrently with medical treatment	59 (47.6)
After medical treatment but before surgery	42 (33.9)
After medical treatment and surgery	1 (0.8)

What influences your LTP practice patterns the most?	122
Evidence in literature	50 (40.3)
Teaching during training	19 (15.3)
Past clinical experience	53 (42.7)
Other	2 (1.6)

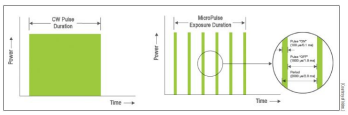
Would you benefit from a practice guideline for a laser trabeculoplasty?	124
Yes	105 (84.7)
No	19 (15.3)

SLT Pearls

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

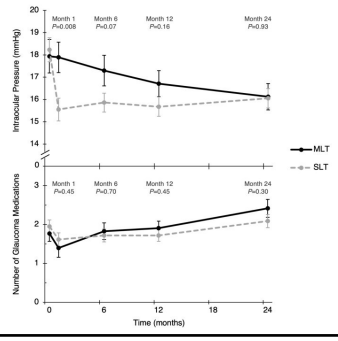
Micropulse laser trabeculoplasty (MLT)

- Delivers small, repetitive micropulses rather than one continuous pulse
  - Cooling periods between micropulses reduces tissue damage
  - Does not destroy pigmented cells
  - Less pain during and after procedure



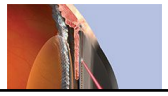
Clinical Ophthalmology
Dovepress
ORIGINAL RESEARCH

Clinical Outcomes of Micropulse Laser Trabeculoplasty Compared to Selective Laser Trabeculoplasty at One Year in Open-Angle Glaucoma



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



Novel SLT approaches

REVIEW

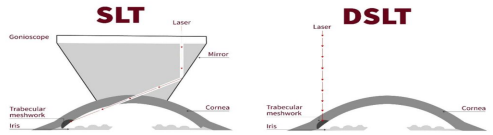
A Review of Selective Laser Trabeculoplasty: Recent Findings and Current Perspectives

Yujia Zhou · Ahmad A. Aref

- 2018 Review:
  - Shorter time interval between the initial and repeat SLT can result in higher success rates because of ongoing action of initial SLT application

Novel SLT approaches

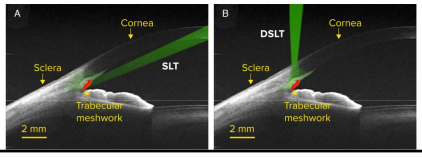
- Trans-scleral approach (Direct SLT)
  - 2014 ARVO paper
  - SLT applied to sclera overlying TM
  - IOP reduction equivalent to traditional SLT



Automated Direct Selective Laser Trabeculoplasty: First Prospective Clinical Trial

Mordechai Goldenfeld[1], Michael Belkin[2], Masha Dobkin-Bekman[3], Zachary Sacks[3], Sharon Blum Meirovitch[1], Noa Geffen[4,5], Ari Leshno[1,4], and Alon Skaat[1,4]

[1] The Sam Rothberg Glaucoma Centre, Goldschleger Eye Institute, Sheba Medical Centre, Tel Hashomer, Israel
[2] Goldschleger Eye Research Institute, Tel Aviv University, Sheba Medical Centre, Tel Hashomer, Israel
[3] BELKIN Laser, Ltd, Yavne, Israel
[4] Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel
[5] Rabin Medical Centre, Petach Tikvah, Israel



Direct SLT Goldenfeld et. al (2021)

- 15 eyes IOP >21mmHg
- OAG, OHTN, PXG
- 1mJ for 100 shots versus 1.4mJ for 120 shots

Direct SLT Goldenfeld et. al (2021)

		1 Month Postop			3 Months Postop			6 Months Postop		
Total Cohort and Subgroups	Baseline IOP[a]	IOP	% Reduction	P	IOP	% Reduction	P	IOP	% Reduction	P
Total cohort (n = 15)[b]	26.7 ± 2.3	21.7 ± 4.2	18.1	0.005	20.8 ± 2.5	21.4	<0.001	21.5 ± 4.0	18.8	0.003
≥ 1 mJ/shot (n = 13)[b,c]	26.8 ± 2.5	21.5 ± 4.4	19.4	0.001	20.7 ± 2.7	22.1	0.001	20.7 ± 3.8	22	0.002
0.8 mJ/shot (n = 2)	26 ± 0.7	23.5 ± 0.7	9.6	ND	21.5 ± 0.7	17.0	ND	26 ± 2.8	0	ND
1 mJ/shot (n = 6)[b]	27.3 ± 2.0	20.0 ± 4.2	26.4	0.03	22.0 ± 2.4	18.4	0.06	22.7 ± 5.1	15.2	0.3
1.4 mJ/shot (n = 6)	26.7 ± 3.2	21.2 ± 2.3	19.9	0.06	19.8 ± 2.9	24.9	0.03	19.3 ± 2.0	27.1	0.03

Direct SLT

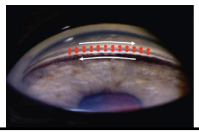
- EAGLE Device (External Automatic GLaucoma LasEr)
  - Automated device being investigated
  - 100 spots simultaneously
  - 1 second treatment time
  - No gonio lens

Direct SLT- What's the point?

- "Given the efficacy of SLT, we considered ways to simplify the procedure. We achieved this goal by irradiating the TM through the limbus."
- "It is possible that a simpler SLT would make general ophthalmologists and other trained allied health professionals more inclined to use it"
- "Optometrists and glaucoma nurses are likely to provide eyecare in the years ahead"

Pattern SLT (PSLT)

- Computer-guided treatment algorithm
- Spots are placed without overlap or gaps
- 100um spot size; 3 rows
- 400mJ/mm (PSLT) vs 9mJ/mm (SLT)



Acta Ophthalmologica

Acta Ophthalmologica 2021

Outcomes of pattern scanning laser trabeculoplasty and selective laser trabeculoplasty: Results from the lausanne laser trabeculoplasty registry

Sina Elahi,[1] Harsha L. Rao,[2] Archibald Paillard[1] and Kaweh Mansouri[1,3]

[1]Glaucoma Research Center, Montchoisi Clinic,Swiss Visio, Lausanne, Switzerland
[2]Narayana Nethralaya, Bangalore, India
[3]Department of Ophthalmology, University of Colorado School of Medicine, Denver, Colorado, USA

Efficacy and safety of selective laser trabeculoplasty and pattern scanning laser trabeculoplasty: a randomised clinical trial

Mandy Oi Man Wong,[1,2] Isabel SW Lai,[1,2] Poemen Puiman Chan [1,2] Noel CY Chan,[1,3] Alison YY Chan,[1,2] Gilda WK Lai,[1] Vivian SM Chiu,[1] Christopher Kai-Shun Leung [1,2]

- Success = 20% reduction in IOP
- SLT 25% success
- PSLT 15% success

- "PSLT is similar in safety and not superior in efficacy compared to SLT"

American Journal of Ophthalmology Case Reports 18 (2020) 100675

Contents lists available at ScienceDirect

American Journal of Ophthalmology Case Reports

journal homepage: www.elsevier.com/locate/ajoc

Hypopyon following selective laser trabeculoplasty

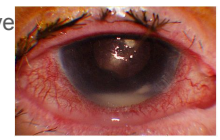
Lisa R. Koenig*, Kyle D. Kovacs, Mrinali P. Gupta, Sarah H. Van Tassel

Weill Cornell Medical College, Department of Ophthalmology, New York, NY, United States

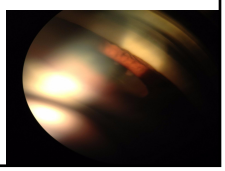
- 85 yr old woman with POAG
- Routine SLT (95 total mJ 360)

Day 6 Post SLT

- HM vision
- IOP 32mmHg
- Epithelial defect
- Unremarkable uveitis w/u
- A/c paracentesis negative

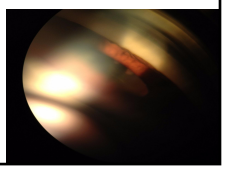


- +5.00 hyperope
- IOP 16 OU
- C/D 0.3 OU, healthy rim tissue
- Angle opens to scleral spur with indentation
- rNFL healthy by OCT
- VF normal OU



Laser peripheral iridotomy (LPI)

- How likely is this patient to develop glaucoma?
- How do we predict whether she will progress?
- How effective is LPI?
- What do we do if LPI fails?



How are we doing?

Eye
https://doi.org/10.1038/s41433-020-1003-0

The ROYAL COLLEGE of OPHTHALMOLOGISTS

ARTICLE

Predictors of narrow angle detection rate—a longitudinal study of Massachusetts residents over 1.7 million person years

Cecilia S. Lee[1] · Michael L. Lee[2] · Ryan T. Yanagihara[1] · Aaron Y. Lee[1]

Received: 2 March 2020 / Revised: 14 May 2020 / Accepted: 21 May 2020

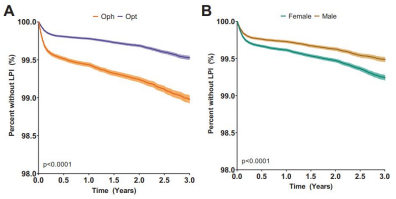


Fig. 1 Kaplan–Meier curves on narrow angle detection in patients grouped by type of provider (a) and sex (b). *X*-axis: years since the first eye evaluation. *Y*-axis: percent of study population who has not received laser peripheral iridotomy (LPI). **a** Purple: patients seen by optometrists; Orange: patients seen by ophthalmologists; **b** Yellow: male; Green: female.

Conclusions

- "Lower rate of narrow angle detection in patients who are only followed by optometrists has important clinical implications"
- "Evaluation by ophthalmologists may benefit patients who are at increased risk of PACG"
- "These differences raise concerns regarding recently increased scope of practice for optometrists in some US states"

Iridotomy OMD Curriculum

MedEdPORTAL® | The AAMC Journal of Teaching and Learning Resources

Original Publication Open Access

Laser Peripheral Iridotomy Curriculum: Lecture and Simulation Practical

Joanne C. Wen, MD*, Kasra A. Rezaei, MD, Deborah L. Lam, MD

- OMD residents must perform at least four LPIs prior to graduating
- "Formal training is often lacking"
- Present a model curriculum from University of Washington

Educational Objectives

By the end of this session, learners will be able to:

1. List the indications for laser peripheral iridotomy (LPI).
2. Accurately explain the LPI procedure and postprocedure management to patients and obtain informed consent.
3. Become proficient in the technical skills involved with performing safe and effective LPIs.

Figure 1. Example of laser simulation setup with the SimulEYE slit lamp holder and SimulEYE LPI model eye.

How do we classify the angle?

- Based on chronicity
  - Acute
  - Chronic
  - (Subacute, intermittent, latent, creeping…)
- Based on glaucomatous damage
  - Primary angle closure suspect
  - Primary angle closure
  - Primary angle closure glaucoma
- Based on etiology
  - Pupillary block
  - Other

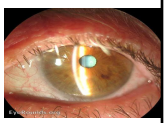
Chronicity

- Acute
- Chronic

Acute angle closure

- Pain
- Conjunctival hyperemia
- Hazy cornea
- Mid-dilated pupil
- Glare
- Nausea

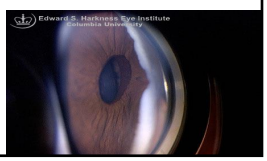
- Only 20-30% of angle closure cases



Chronic angle closure

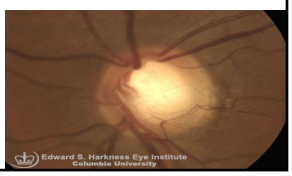
- Peripheral anterior synechiae (PAS)
- Permanently closed angle
- Elevated IOP
- Usually asymptomatic

–Gradual
–Regular gonio essential!



Classification: Glaucomatous Damage

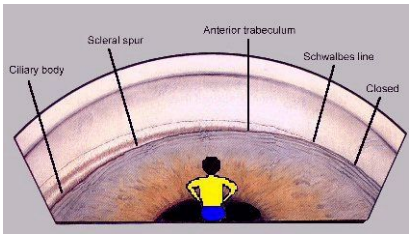
- Primary angle closure suspect
- Primary angle closure
- Primary angle closure glaucoma



Primary angle closure suspect

- Very commonly encountered
- No elevated IOP
- No anterior synechiae
- No glaucomatous damage
- No visual field loss

- Iridotrabecular contact is present or considered to be possible

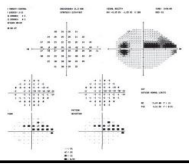


Primary angle closure

- Evidence of previous or current angle closure
  - Elevated IOP, anterior synechiae
- No glaucomatous damage

Primary angle closure glaucoma

- Glaucomatous nerve damage and/or visual field loss consistent with glaucoma



A Helpful Classification Scheme

1. Anatomically narrow
   - Indentation gonioscopy opens angle
   - Normal IOP
   - Heightened suspicion
2. Anterior synechiae and/or elevated IOP
   - Minimal natural history data
3. Closed angles and glaucomatous damage

(Fourth category: Acute symptomatic angle closure)

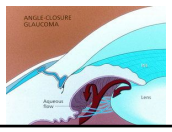
A Helpful Classification Scheme

1. Anatomically narrow
   - Indentation gonioscopy opens angle
   - Normal IOP
   - Heightened suspicion
2. Anterior synechiae and/or elevated IOP
   - Minimal natural history data
3. Closed angles and glaucomatous damage

(Fourth category: Acute symptomatic angle closure)

Narrow Angles

- What qualifies as narrow?
- How do we measure and quantify the angle?



Measuring the Angle

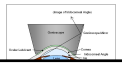
•van Herick
•Gonioscopy
•Anterior segment OCT
•Scheimpflug imaging
•Ultrasound biomicroscopy

van Herick

- Occludable angle: Anterior chamber depth less than one fourth of corneal thickness

Gonioscopy

- More detailed than van Herick
- Subjective and more difficult
- Perform in dim light to avoid pupil constriction and falsely open angles



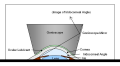
Gonioscopy

- What is an occludable angle?

–(Caveat: No clear consensus)

- Failure to view the posterior trabecular meshwork in at least 180 degrees
- In other words: Iridotrabecular contact for greater than 180 degrees

- (Without compression/indentation)



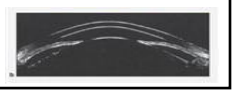
Gonioscopy

- Underutilized, according to chart review studies and Medicare billing data
- Remains gold standard for angle measurement

Anterior Segment OCT

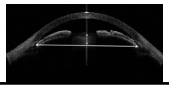
- Easy to perform; noninvasive
- May be performed in dark
- No visualization of synechiae, pigment, or neovascularization

- Consider iridotomy if angle opening is less than 5-10 degrees



How narrow is too narrow?

- Gonioscopy: iridotrabecular contact for 180 degrees
  - Iridotrabecular contact= failure to see posterior meshwork
- AS-OCT: angle opening is less than 5-10 degrees
  - Visante: use lens vault measurement



When to recommend prophylactic LPI?

When to recommend prophylactic LPI?

1. Anatomically narrow
   - Indentation gonioscopy opens angle
   - Normal IOP
   - Heightened suspicion
2. Anterior synechiae and/or elevated IOP
   - Minimal natural history data
3. Closed angles and glaucomatous damage

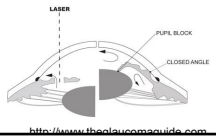
(Fourth category: Acute symptomatic angle closure)

When to recommend prophylactic LPI

- Narrow angle and presence of any:
  - Peripheral anterior synechiae
  - Elevated IOP
  - Optic nerve damage
  - Family history
- Narrow angle without any of these: discuss risks, involve patient in decision
  - Retinal disease, requires dilation?
  - Travels to remote areas?
  - Unlikely to follow up?
  - Takes medication that increases risk?

Iridotomy

- Relieves resistance in the iris-lens channel
  - Provides alternate route for aqueous flow
- Iris flattens, angle widens



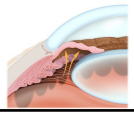
http://www.theglaucomaguide.com

Pupillary block

- AKA primary angle closure
- Most common mechanism
- Iridolenticular contact disrupts flow of aqueous
  - Accumulates in posterior chamber
  - Iris bombe
  - Angle closure

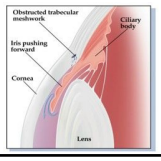
Pupillary block

- May result from pupil dilation
  - Pharmacologic or physiologic
  - Most likely at mid-dilated state as pupil recovers from dilation
  - Peripheral iris laxity caused by dilation → iris bombe



Important concept: *Relative* pupillary block

- No iridolenticular contact
- Relative resistance to aqueous flow
- Aqueous pressure is higher behind the iris (and at optic nerve)
  - One to eight mmHg
  - Equalized by iridotomy
- **Main known causative mechanism of ACG**



Does LPI work?

AMERICAN ACADEMY OF OPHTHALMOLOGY

Ophthalmic Technology Assessment

Laser Peripheral Iridotomy in Primary Angle Closure

A Report by the American Academy of Ophthalmology

- "Of note, the level of evidence was fairly low. Most of the studies (53%, 19/36) were of level III evidence, and 28% (10/36) and 17% (6/36) of the studies were of level II and level I evidence, respectively. In addition, 81% of the studies (29/36) included Asian subjects only"

Does LPI work?

- PACS
  - Up to 25% may not respond
    - Suggests nonpupillary block
  - Most require no additional treatment
  - Very low risk of acute attack following LPI
- PAC and PACG
  - Many require additional treatment

ELSEVIER

Ophthalmology
Volume 121, Issue 9, September 2014, Pages 1699-1705

Original article

Longitudinal Changes of Angle Configuration in Primary Angle-Closure Suspects: The Zhongshan Angle-Closure Prevention Trial

Yuzhen Jiang MSc, MD [1,2], Dolly S. Chang MD, PhD [2,3], Haogang Zhu MSc, PhD [1], Anthony P. Khawaja MPhil, FRCOphth [4], Tin Aung PhD, FRCS(Ed) [5], Shengsong Huang MSc, MD [2], Qianyun Chen BA, MA [2], Beatriz Munoz MSc [3], Carlota M. Grossi BSc, PhD [3], Mingguang He MD, PhD [1,2,*], Ai, David S. Friedman MD, PhD [2,3,6,*], Paul J. Foster PhD, FRCS(Ed) [1,2,7,*]

ZAP Trial

- Six year prospective RCT
  - One eye per patient gets LPI
- 889 patients with PACS
- How many would develop PAC? (IOP greater than 24mmHg, PAS, or acute attack)

How many progressed to PAC?

- Untreated eyes: 36 (8 per 1000 eye-years)
- Treated eyes: 19 (4 per 1000 eye-years)
- Limitations:
  - Exclusion criteria
  - Non-contact tonometry
  - Limited to Chinese patients
- No OHTS-style calculator

Appositional angle closure and conversion of primary angle closure into glaucoma after laser peripheral iridotomy

Li Qiu,[1,2] Yujie Yan,[1,3] Lingling Wu [1]

- 128 PAC patients received LPI in China
- Looked at conversion from PAC to PACG more than 5 years after LPI

Conclusions

- 25% of PAC eyes converted to PACG during mean follow-up of 6.6 years
- Difficulty applying this to different ethnicities

Table 2 Baseline characteristics of the PAC converting (PAC converting into PACG) and PAC non-converting groups

	PAC converting (n=18)	PAC non-converting (n=40)	P value
Age (years)	67.0±8.63	61.15±8.24	0.017*
Sex (male/female)	8/10	12/28	0.284†
Duration of follow-up (years)	6.83±1.29	6.60±1.35	0.541*

*Independent sample t-test for age and follow-up duration.
†χ^2 test for sex.
PAC, primary angle closure; PACG, primary angle closure glaucoma.

Table 3 Baseline AppAC range and angle closure of converting and non-converting eye groups

	Converting eyes (n=20)	Non-converting eyes (n=60)	P value
AppAC range (quadrant)			
> 1	40.0% (8/20)	30.0% (18/60)	0.408
> 2	35.0% (7/20)	8.3% (5/60)	0.008* (CR: 0.308, p=0.004)
Synechia angle closure range (quadrant)			
Positive	80.0% (16/20)	60.0% (36/60)	0.104
Synechia angle closure plus AppAC range (quadrant)			
> 1	70.0% (14/20)	58.3% (35/60)	0.354
> 2	50.0% (10/20)	23.3% (14/60)	0.024 (CR: 0.224, p=0.024)

Iridotomy learning curve

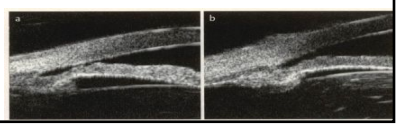
- 2017 comparison of LPIs performed by 1st/2nd/3rd year ophthalmology residents
- Compared total energy usage (approximates efficiency)
  - Decreasing energy with experience
- Compared complications
  - No difference

Iridotomy learning curve

- "Complications included elevated post-laser IOP at 30–45 minutes (≥8 mmHg), hyphema, aborted procedures, and lasering non-iris structures."

Iridotomy size

- What is proper iridotomy size?
- No consensus
- One study revised "small" iridotomies (<100um) and angle deepened
- Aim for ≥200um



Iridotomy Pearls

- Identify and avoid blood vessels

–Stromal fibers
•Straight and radial
•Thin
–Blood vessels
•Circuitous course
•Thicker
•May see column of RBCs in lumen

Iridotomy Pearls

- Assessing patency

–Retroillumination is NOT sufficient
–High mag, high illumination
•Iridotomy should be pitch black
•White/gray film needs revision

Iridotomy Pearls

- Blue vs brown iris

–Blue tends to be thinner and much easier to penetrate

–Brown is more difficult to penetrate

- Sometimes requires two sessions to finish
- Throws off a lot of pigment/debris

Iridotomy Efficacy

- Up to 30% of eyes retain narrow angles following iridotomy
  - Very few of these go on to have attacks of increased IOP
  - Make sure iridotomy is large enough
  - Consider cataract surgery, iridoplasty, topical therapy, outflow surgery

Iridotomy Risks & Complications

- Uveitis
- IOP spike
- Hyphema
- Synechia formation
- Monocular diplopia/glare
- Bullous keratopathy

–(Japan: 20% of PKPs)

- Cataract?

Case Report

Descemet's Membrane Injury Post YAG Peripheral Iridotomy

Harsh Kumar, Chirag Mittal, Arushi Puri

Centre For Sight Eye Hospital, New Delhi, India

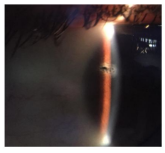


Figure 1. *Anterior segment photograph of Right eye showing three small circular defects in the Descemet's membrane just above the lasered PI.*

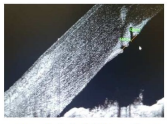
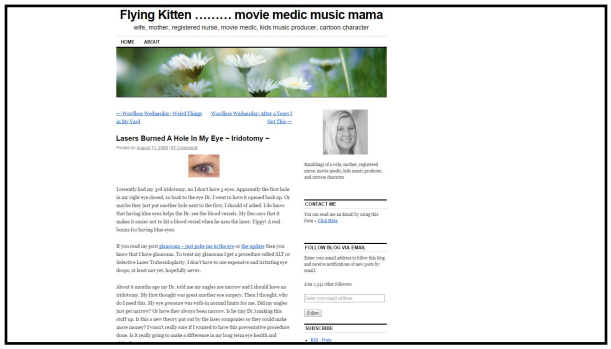


Figure 2. *Anterior- Segment OCT of Right eye shows two defects in the descemet's membrane.*

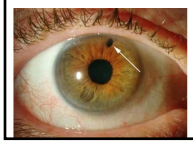
Iridotomy placement location

- How can we minimize photopsia complications?



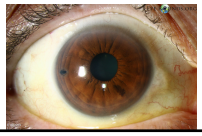
Iridotomy placement location

- Traditionally placed at 11:00 or 1:00



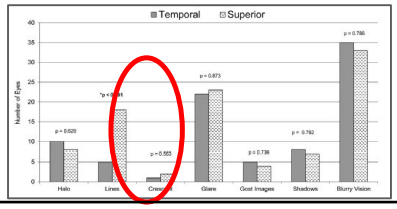
Iridotomy placement location

- 2014 prospective randomized trial
- 169 patients
  - Randomized to superior LPI in one eye and temporal LPI in other eye
- Looked for linear dysphotopsia as complication



Iridotomy placement location

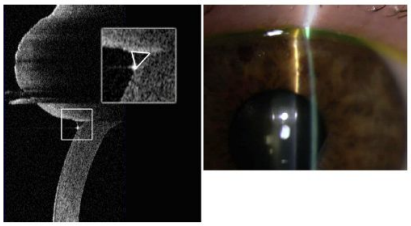
- New-onset linear dysphotopsia
  - 10.7% (superior) vs 2.4% (temporal)



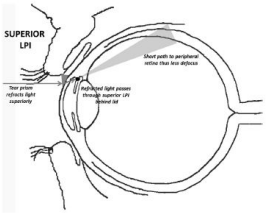
Iridotomy placement location

- Superior placement
  - 75% fully covered by lid
  - 17% partially exposed
  - 8% completely exposed
- Temporal placement
  - 98% completely exposed
- Rate of linear dysphotopsia
  - 2.8% fully exposed iridotomies
  - 11.3% partially or completely covered iridotomies

Iridotomy placement location

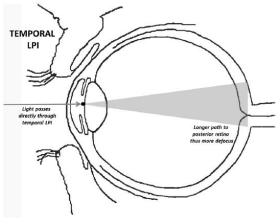


Iridotomy placement location



Vera et. al 2014

Iridotomy placement location



Vera et. al 2014

Iridotomy placement location

- 2018 prospective RCT (n=559) found no difference in visual disturbances for superior vs nasal/temporal

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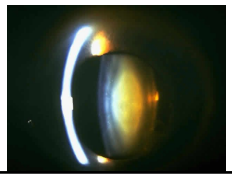
Anatomic Changes and Predictors of Angle Widening after Laser Peripheral Iridotomy

The Zhongshan Angle Closure Prevention Trial

- Superior LPIs had greater angle widening vs horizontal
  - (This result has not been reproduced elsewhere)

Lens extraction vs LPI

- Emanuel (2014): cataract extraction may be more effective at controlling IOP than iridotomy



Lens extraction vs LPI

- EAGLE trial (2016)
- Clear lens extraction vs LPI
- PAC with IOP > 30 or PACG
- Clear lens extraction had greater efficacy and was more cost-effective

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Survey of Ophthalmology

Major review

Clear lens extraction in eyes with primary angle closure and primary angle-closure glaucoma

Vital P. Costa, MD, PhD[a,], Christopher K.S. Leung, MD, PhD[b], Michael S. Kook, MD[c], Shan C. Lin, MD[d], On behalf of the Global Glaucoma Academy*

Table 1 – Summary of clinical studies: phacoemulsification and IOL implantation in eyes with cataract and PAC or PACG

Author	Sample size	PAC or PACG	Mean follow-up (months)	Preoperative IOP (mm Hg)	Postoperative IOP (mm Hg)	% IOP reduction	Preoperative # meds	Postoperative # meds	% reduction in # meds
Hayashi et al[17] (2005)	74	PACG	25	21.4	14.5	34	1.3	0.6	53.8
Di Biase et al[18] (2006)	12	PACG	9	21	15	28.6	2.1	1.0	52.4
Nonaka et al[19] (2009)	17	PACS/PACI PACG	3	19.3	14.8	23.3	No data	No data	No data
Lai et al[20] (2008)	21	PACG	20.7	19.7	15.5	21.3	1.91	0.52	73.6
Lam et al[21] (2008)	29	PACG	3	14.3	12.2	14.7	1.93	0.83	57
Thorn et al[22] (2008)	35	Medically controlled PACG	24	18.3	13.2	19	2.2	1.1	50
Mierzejewski et al[23] (2008)	29	PACG	15.9	28	14	50	1.5	1.2	20
Hata et al[24] (2008)	27	Medically controlled PACP/ACG	6	14.8	10.8	27	0.4	0	100
Zhao et al[25] (2009)	10	Medically uncontrolled PACG	6	32	16.7	47.8	3	0.2	93.3
Thorn et al (2009)[26]	27	Medically uncontrolled PACG	24	24.6	16.1	34	3.3	1.7	48.5
Liu et al[27] (2010)	90	PACG	12	18.4	13.5	18	1.8	1.0	44.4
Alsagoff and Foster[28] (2011)	54	PACP/ACG	Mean 7.2	18.7	14.1	24.6	No data	No data	No data
Lavik et al[29] (2013)	62	PACG	1.5	23.1	16	30.7	1.1	0.07	93.6
Moghimi et al[30] (2013)	46	PACG	12	22.3	14.9	37	1.2	0.1	91.4
Tham et al[31] (2014)	36	PACG	6	19.8	13.7	30.8	No data	No data	No data
Öyvind et al[32] (2016)	39	PACG	3	18.5	14	24.3	1.9	0.8	57.9
Selvan et al[33] (2019)	18	PAC	6	31.6	14	55.7	4	2	50

IOP, intraocular pressure; PAC, primary angle closure; PACG, primary angle-closure glaucoma; PACS, primary angle closure suspects.
* Some eyes had clear lens, but the exact number was not mentioned in the manuscript.

Conclusion

"Ten years ago, performing clear lens phacoemulsification in eyes with angle closure would probably have been considered unethical. With the scientific evidence that has been built over the past decade, it is evident that clear lens extraction is beneficial in eyes with PAC and PACG"

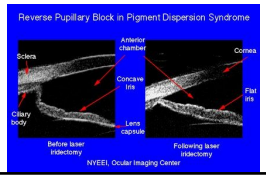
A Helpful Classification Scheme

1. Anatomically narrow
   - Indentation gonioscopy opens angle
   - Normal IOP
   - Heightened suspicion
2. Anterior synechiae and/or elevated IOP
   - Minimal natural history data
3. Closed angles and glaucomatous damage

(Fourth category: Acute symptomatic angle closure)

Pigment dispersion glaucoma & LPI

- Posterior bowing of iris may cause contact between iris and lens zonules
- Iridotomy equalizes pressure and flattens iris



Pigment dispersion glaucoma & LPI

- Scott et. al (2011)
  - Prospective randomized trial
  - 116 eyes with PDS and OHTN, no glaucoma
  - 3 years follow up
  - Randomized to LPI vs observation
  - No differences in glaucoma development or use of glaucoma medications

Cochrane Database of Systematic Reviews

Peripheral iridotomy for pigmentary glaucoma

Cochrane Systematic Review - **Intervention** | Version published: 12 February 2016

https://doi.org/10.1002/14651858.CD005655.pub2

- Five RCTs
- 260 eyes
- PDS and PDG

- Objective: Assess the effects of peripheral laser iridotomy compared with other interventions... or no treatment, for pigment dispersion syndrome and pigmentary glaucoma

Cochrane Database of Systematic Reviews

Peripheral iridotomy for pigmentary glaucoma

Cochrane Systematic Review - **Intervention** | Version published: 12 February 2016

https://doi.org/10.1002/14651858.CD005655.pub2

"In conclusion, evidence is inadequate to support the use of peripheral iridotomy as treatment for pigmentary glaucoma. Well-designed randomized controlled trials are needed to evaluate the effectiveness and safety of peripheral iridotomy for PDS and pigmentary glaucoma."

Questions?

- Thank you!