Laser Trabeculoplasty for Open-Angle Glaucoma

A Report by the American Academy of Ophthalmology

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Objective: To provide an evidence-based summary of the outcomes, repeatability, and safety of laser trabeculoplasty for open-angle glaucoma.

Methods: A search of the peer-reviewed literature in the PubMed and the Cochrane Library databases was conducted in June 2008 and was last repeated in March 2010 with no date or language restrictions. The search yielded 637 unique citations, of which 145 were considered to be of possible clinical relevance for further review and were included in the evidence analysis.

Results: Level I evidence indicates an acceptable long-term efficacy of initial argon laser trabeculoplasty for open-angle glaucoma compared with initial medical treatment. Among the remaining studies, level II evidence supports the efficacy of selective laser trabeculoplasty for lowering intraocular pressure for patients with open-angle glaucoma. Level III evidence supports the efficacy of repeat use of laser trabeculoplasty.

Conclusions: Laser trabeculoplasty is successful in lowering intraocular pressure for patients with open-angle glaucoma. At this time, there is no literature establishing the superiority of any particular form of laser trabeculoplasty. The theories of action of laser trabeculoplasty are not elucidated fully. Further research into the differences among the lasers used in trabeculoplasty, the repeatability of the procedure, and techniques of treatment is necessary.

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The American Academy of Ophthalmology prepares Ophthalmic Technology Assessments to evaluate new and existing procedures, drugs, and diagnostic and screening tests. The goal of an Ophthalmic Technology Assessment is to evaluate the peer-reviewed scientific literature to define what is well established and to help refine the important questions to be answered by future investigations. After appropriate review by members of the Ophthalmic Technology Assessment Committee, other Academy committees, relevant subspecialty societies, and legal counsel, assessments are submitted to the Academy's Board of Trustees for consideration as official Academy statements. This assessment addresses the outcomes and safety of laser trabeculoplasty for the treatment of open-angle glaucoma.

Background

Trabeculoplasty is the common term for the application of laser, in a repetitive fashion, to the trabecular meshwork. Krasnov[1] first reported the use of a laser on the trabecular meshwork to treat glaucoma in 1972. He used a ruby laser and believed that he was puncturing the meshwork to increase aqueous outflow. Hager[2] reported the use of the argon laser, thinking that it caused trabeculopuncture. In a later publication, Krasnov[3] reported lowered intraocular pressure (IOP) with a Q-switched ruby laser.

The mechanism of action of laser trabeculoplasty remains uncertain. Wise[4] proposed that coagulation caused by the laser burns results in a contracture of adjacent tissue, thereby tightening the trabecular ring and perhaps widening the adjacent trabecular pores. Van Buskirk et al[5] proposed 2 additional mechanisms of action in the trabecular meshwork, cellular and biochemical, in response to laser trabeculoplasty. Laser trabeculoplasty induces cell division[6] with subsequent renewal of cellularity, and this may restore the health of the trabecular beams. These theories on the mechanism of laser trabeculoplasty are not mutually exclusive. Laser treatment to the meshwork induces cell division and, in some instances, may create burns, resulting in contracting and subsequent stretching of the trabecular meshwork. It also may generate the renewal of matrix metalloproteinases on the beams and may stimulate the macrophage-like capacity of the trabecular-lining cells.[7]

The trabecular meshwork has a multitude of responses to injury, but these may not be particularly stimulus specific; in fact, there is no evidence to suggest that they are. Furthermore, the various lasers used for trabeculoplasty may vary in the degree to which they invoke these mechanisms. The status of the meshwork may mitigate any or all of these responses with aging; for example, it may mitigate the response in the sclerotic meshwork of some elderly individuals, whereas in younger patients, there may be a shorter

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duration of effect in the meshwork, which has a higher degree of cellular viability.[8] It is clear that laser trabeculoplasty releases cytokines such as interleukin-1β and tumor necrosis factor-α.[9,10] In perfused human organ explants, these cytokines have been demonstrated to alter matrix metalloproteinases and enhance aqueous outflow. These cytokines also may induce cell division, particularly in trabecular cells located in the insert region, the triangular wedge located under Schwalbe's line. Cells in this region may migrate out onto the beams after they are stimulated.[11] The biochemical changes that affect outflow after trabeculoplasty take 4 to 6 weeks to occur. The finding of a delayed response frequently has been invoked by researchers as favoring the biochemical theories of the laser mechanism.

Argon Laser Trabeculoplasty

The first lowering of IOP attributed to the use of an argon laser was reported by Worthen and Wickham[12] in 1973. In 1974, they published results using the procedure in patients with uncontrolled glaucoma, calling it laser trabeculotomy.[13] The value of the procedure was questioned by Gaasterland and Kupfer[14]; in an attempt to create an animal model, they reported that glaucoma could be created in primates by applying confluent laser energy to the meshwork. The initial impression was confusing because one group had found that the laser was effective in lowering IOP, whereas another group found that it elevated the IOP. In 1979, Wise and Witter[15] reported on a series of 56 cases followed up for 18 months after treatment and concluded that trabecular argon laser treatment was as effective as trabeculectomy. In 1981, Schwartz et al[16] followed up 35 patients for 18 months and reported poor efficacy in African Americans. A report by Schultz et al[17] in 1987 suggested that there were improvements in visual field findings related to argon laser trabeculoplasty (ALT), but practice effect, which can increase patients' performance on visual field testing, may have been present.

Diode Laser Trabeculoplasty

The diode laser is more compact, solid state, and portable compared with the argon laser and has been used for trabeculoplasty. Studies suggest that outcomes and safety of trabeculoplasty performed with the diode laser are similar to those of ALT.[18–21]

Selective Laser Trabeculoplasty

A frequency-doubled short-pulsed (Q-switched) neodymium: yttrium–aluminum– garnet laser also been used for trabeculoplasty. This procedure, called selective laser trabeculoplasty (SLT), is based on the theory that there is a selective effect on melanotic elements associated with the meshwork. Histologic studies have shown that there is less coagulative damage after SLT and less structural change of the meshwork,[22] which gives the laser a theoretical appeal.

Micropulse-Diode Laser Trabeculoplasty

The laser used in micropulse-diode laser trabeculoplasty (MDLT) produces micropulses of very short duration with the goal of lessening the thermal damage created by the argon laser, including the subsequent scarring of the trabecular meshwork. There is a visible tissue blanching response to argon laser that allows its titration and a visible tissue jiggle with SLT, but no significant tissue response is seen with MDLT. Micropulse-diode laser trabeculoplasty is a large-spot, low-irradiance treatment that uses an 810-nm diode laser that emits a train of repetitive short near-infrared laser pulses to confine the laser-induced thermal effect spatially. This produces the intended sublethal photothermal effects and elicits a therapy stress response in trabecular cells. With shorter-duration pulses, less heat can spread toward adjacent cooler tissue, which better confines the thermal effect to absorbing melanosomes. The longer the cooling time between pulses, the more thermal relaxation with equilibration toward baseline temperatures occurs. Theoretically, each micropulse can elevate a cell's temperature by only a few degrees without coagulative necrosis.

Titanium-Sapphire Laser Trabeculoplasty

The wavelength of the titanium-sapphire laser is 790 nm, is near infrared, and is similar to the micropulse-diode laser, but it is longer than the green wavelength of the argon laser or the laser used in SLT. The effect of titanium-sapphire laser trabeculoplasty with an infrared laser wavelength may be related to the biology of the meshwork because treatment with this laser should lead to deeper penetration to the juxtacanalicular meshwork, where it may have a direct effect on outflow. The primary site of outflow resistance of aqueous humor is the juxtacanalicular meshwork.

Food and Drug Administration Status

Table 1 lists the characteristics and treatment parameters of the lasers used in trabeculoplasty. The lasers discussed in this assessment have received United States Food and Drug Administration clearance for marketing as substantially equivalent (510K) devices.

Resource Requirements

Laser trabeculoplasty generally takes less than 20 minutes. The principal costs are the laser and the gonioscopy lens used to apply the treatment. The gonioscopy lens should have an antireflectivity coating treatment appropriate for the laser wavelength that is being used. In addition to this equipment, a viscous solution for application of the lens, topical anesthetic, and medication to lower IOP in the period immediately after surgery are needed. At present, the 810-nm infrared diode laser used for MDLT seems to be less expensive than the other lasers described. In a Markov model simulating the total cost of glaucoma treatment over a 5-year period, laser trabeculoplasty was associated with lower costs when compared with the medication and filtering-surgery groups.[23]

Table 1. Comparison of Various Laser Trabeculoplasty Techniques and Treatment Parameters within the Range Considered Typical for Average Patients

Characteristics and Parameter	Units	Continuous Wave-Laser Trabeculoplasty		Pulsed-Laser Trabeculoplasty		
		*Argon Laser Trabeculoplasty**†‡	*Diode Laser Trabeculoplasty**†‡	*Selective Laser Trabeculoplasty*†‡	*Microdiode Laser Trabeculoplasty*§‖¶	*Titanium Laser Trabeculoplasty*#
Contact gonio lens (laser magnification)	−/−	Goldmann 3-mirror lens (×1.08)	Ritch trabeculoplasty (×0.71)	Latina laser gonio lens (×1.0)	Latina laser gonio lens (×1.0)	Goldmann 3-mirror lens (×1.08)
Laser wavelength	nm	488/514 (or 532)	810	532	810	790
(Spot diameter in air) spot diameter at tissue	μm	(50) 54	(75) 53	(400) 400	(200–300) 200–300	(200) 216
Laser power	W	0.4–0.7	0.6–1.0	$200–400\times10^3$	2	$4.3–17.1\times10^3$
Laser irradiance	W/cm^2	$20–36\times10^3$	$30–50\times10^3$	$160–320\times10^6$	$2.83–6.37\times10^3$	$13.7–54.5\times10^6$
Laser pulse length	s	0.1	0.1–0.2	3×10^{-9}	300×10^{-6}	7×10^{-6}
Pulses/application site (time–% duty factor)	no. (sec)	1 (0.1 sec–100%)	1 (0.1–0.2 sec–100%)	1 (3×10^{-9} sec–100%)	100 (0.2 sec at 15%)	1 (7×10^{-6} sec–100%)
Laser energy per pulse (per application site)	J	$40–70\times10^{-3}$	$60–200\times10^{-3}$	$0.6–1.2\times10^{-3}$	0.6×10^{-3} (60×10^{-3})	$40–80\times10^{-3}$
Laser fluence per pulse (per application site)	J/cm^2	$2.0–3.6\times10^3$	$3.0–10\times10^3$	0.5–1.0	0.85–1.91 (85–191)	$4.1–16.3\times10^3$
Recommended no. of applications and placement over the TM	no.	50 (or 100) spaced over 180° (or 360°)	50 (100) spaced over 180° (360°)	50 (or 100) confluent over 180° (or 360°)	66–100 (or 132–200) confluent over 180° (360°)	50 spaced over the inferior 180°
Treated fraction (%) of the TM circumference	−/−	6.5%–13%	6.5%–13%	50% (or 100%)	50% (or 100%)	50%
Total energy per eye	J	2.0–7.0	3.0–20.0	$30–120\times10^{-3}$	3.96–12.0	2–4
Expected endpoint	−/−	Blanching (mild) to bubbles (intense)	Blanching to no visible reaction (in lightly pigmented TM)	No visible tissue reaction or small bubbles	No visible tissue reaction	Visible TM tissue reaction with microbubbles

TM = trabecular meshwork.
*American Academy of Ophthalmology Committee on Ophthalmic Procedure Assessments. Laser trabeculoplasty for primary open-angle glaucoma. Ophthalmology 1996;103:1706–12.
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Questions for Assessment

The purpose of this assessment is to answer the following questions:

1. What is the amount of IOP lowering reported for laser trabeculoplasty and the duration of treatment effect?
2. How does laser trabeculoplasty compare with alternative forms of medical or surgical therapy in lowering IOP?
3. Are there meaningful differences in safety or outcomes between various lasers?
4. To what degree is laser trabeculoplasty repeatable?

Description of Evidence

The literature search strategy was based on that of the Cochrane systematic review on laser trabeculoplasty for open-angle glaucoma.[24] Literature searches were conducted in June 2008 and were repeated last on March 1, 2010, in the PubMed and the Cochrane Library databases with no date or language restrictions. The search strategy used the MeSH terms *glaucoma*, *open-angle*, and *trabeculectomy* and the text words *trabeculoplast* (truncated), *argon*, *laser* (truncated), *selective*, *ALT*, *SLT*, *sapphire*, *titanium*, *micro*, *diode*, *micropulse*, *neodymium*, and *Nd:YAG*.

The searches yielded 637 citations; of these, 499 were in English. The first author also reviewed the bibliographies pro-

Table 2. Randomized Clinical Trials (Level I) of Laser Trabeculoplasty with Published Results

Name	Study Design	No. of Patients	Follow-up (yrs)	Findings
Glaucoma Laser Trial (GLT)[26,34]	Newly diagnosed POAG: medical therapy vs. laser trabeculoplasty	271	2.5–5.5	Initial laser trabeculoplasty lowered IOP more (–9 mmHg) than initial treatment with topical timolol maleate (–7 mmHg) over 2 yrs; initial laser trabeculoplasty was at least as effective in preserving visual field and optic disc status over 5.5 yrs.
Glaucoma Laser Trial Follow-up Study[26]	Participants in the GLT	203	6–9	Longer follow-up reinforced the earlier findings that initial laser trabeculoplasty lowered IOP more (–1.2 mmHg) than initial treatment with topical timolol maleate and was at least as effective in preserving visual field and optic disc status.
Moorfields Primary Treatment Trial[35]	Newly diagnosed POAG: medical therapy vs. laser trabeculoplasty vs. trabeculectomy	168	5+	Trabeculectomy lowered IOP the most (–60%); laser trabeculoplasty (–38%) and medical therapy (–49%) groups had more deterioration in visual fields than trabeculectomy group.
Early Manifest Glaucoma Trial[27–29]	Newly diagnosed POAG: medical therapy and laser trabeculoplasty vs. no treatment	255	4–10	Lowering IOP with medical therapy and trabeculoplasty (–25%) slowed progression of optic disc and visual field damage.
Advanced Glaucoma Intervention Study (AGIS)[30,31]	POAG after medical therapy failure with no previous surgery: laser trabeculoplasty vs. trabeculectomy	591	10–13	Surgical outcome varied by race; patients with African ancestry did better with trabeculoplasty as first surgery (–30% IOP), whereas in the longer term (4+ yrs), white American patients did better with trabeculectomy as first surgery (–48% IOP). Lowest IOP group during follow-up after surgical interventions (–47%) protected against further visual field deterioration in advanced glaucoma patients.
Damji et al[39]	Open-angle glaucoma, after medical therapy failure or failed ALT >6 mos previously: ALT vs. selective laser trabeculoplasty	152	1	No significant difference in IOP lowering or early or late complications rates between the groups.

ALT = argon laser trabeculoplasty; GLT = Glaucoma Laser Trial; IOP = intraocular pressure; POAG = primary open-angle glaucoma.
SOURCE: Adapted with permission from the American Academy of Ophthalmology Preferred Practice Patterns Committee Glaucoma Panel. Preferred Practice Pattern® Guidelines. Primary Open-Angle Glaucoma. San Francisco, CA: American Academy of Ophthalmology; 2010. Available at: http://www.aao.org/ppp.

vided by the companies that make lasers and contacted each of them. A comprehensive bibliography maintained by an investigator holding a National Eye Institute research grant (R01) pertaining to laser mechanisms also was reviewed (Ted S. Acott, PhD, personal communication, 2008). The authors reviewed the titles and abstracts of the English-language articles and selected 145 that they considered to be of possible clinical relevance. These articles were reviewed, and the authors assigned ratings of level of evidence with the guidance of the panel methodologist (K.S). The rating scale is based on that developed by the British Centre for Evidence-Based Medicine.[25] A level I rating was assigned to systematic reviews of well-designed and well-conducted randomized clinical trials or individual well-designed and well-conducted randomized clinical trials; a level II rating was assigned to well-designed case-control and cohort studies and poor-quality randomized studies; and a level III rating was assigned to case series, case reports, and poor-quality cohort and case-control studies.

A Cochrane systematic review on laser trabeculoplasty for open-angle glaucoma published in 2008 was rated as level I evidence.[24] The randomized clinical trials that were deemed to meet the criteria for a level I rating are listed in Table 2. All remaining studies, including randomized clinical trials of smaller size and those associated with less rigorous methodology as well as nonrandomized clinical trials, case series, and retrospective reviews were considered level II or III evidence.

Published Results

What is the Amount of Intraocular Pressure Lowering Reported for Laser Trabeculoplasty and the Duration of Treatment Effect?

Studies have found that laser trabeculoplasty provides a clinically significant reduction of IOP in more than 75% of initial treatments of previously unoperated eyes (see Table 2). In the Glaucoma Laser Trial Follow-up Study,[26] 11% of eyes treated at glaucoma diagnosis with ALT had progressed by the end of the long-term follow-up, defined as having either filtering surgery or repeat ALT. By contrast, 34% of eyes in the Glaucoma Laser Trial Follow-up Study that received medication as initial management needed either ALT or filtering surgery. These results indicate an acceptable long-term efficacy of initial ALT compared with initial medical treatment (level I evidence).

The Early Manifest Glaucoma Trial[27,28] enrolled 255 eyes of patients with newly diagnosed glaucoma. Patients were randomized to topical β-blocker and ALT 1 week later or to no laser trabeculoplasty. After a median of 8 years of follow-up, 67% of patients progressed, and multivariate analyses showed that the progression risk was halved by treatment (hazard ratio, 0.53; 95% confidence interval, 0.39–0.72; level I evidence). Laser trabeculoplasty with β-blocker demonstrated a trend toward increased risk of ocular and systemic adverse effects, but there were no statistically significant differences between control and experimental groups.[29] Decreased visual acuity was reported as an adverse effect, and there was no difference between the groups after 5 years of follow-up.[29] The Early Manifest Glaucoma Trial used a Swedish translation of the 25-item National Eye Institute Visual Function Questionnaire and found no significant differences between the groups. The Early Manifest Glaucoma Trial did not address failure to control IOP.

In the Advanced Glaucoma Intervention Study,[30,31] which enrolled patients with medically uncontrolled primary open-angle glaucoma (POAG), analysis of results was divided by self-reported race. A Kaplan-Meier survival analysis at 5 years of eyes that received ALT as the first surgical intervention showed a 30% rate of failure among black patients and a 40% rate of failure among white patients. In both subgroups, the rate increased to approximately 50% by 10 years. Thus, approximately half of eyes treated with ALT at the time of failure of medical management maintained adequate control of IOP with continued medical management 10 years after treatment (level I evidence). A similar assessment of long-term success is not yet available for eyes treated with SLT or MDLT.

Patients with uncontrolled open-angle glaucoma taking maximally tolerated medical therapy who underwent ALT or diode laser trabeculoplasty (DLT) demonstrated a similar time before treatment failure (defined as requiring trabeculectomy); 50% of the DLT eyes and 58% of the ALT eyes were successful at 5 years (level II evidence).[19] In a case series of patients who underwent SLT for POAG, the average reduction in IOP from baseline was 24% (standard deviation, 6.0 mmHg) at 1 year, 28% (6.1 mmHg) after 2 years, 24% (5.5 mmHg) after 3 years, and 29.3% (6.3 mmHg) after 4 years (level III evidence).[32] Patients continued with the same glaucoma medication regimen after SLT as before surgery.

Babighian et al[33] reported that SLT achieved a 2-year success rate (defined as $\geq$20% reduction in IOP without further glaucoma intervention) in 40% in patients with POAG refractory to medical therapy. The mean IOP decreased from 23.9$\pm$0.9 mmHg to 19.1$\pm$1.8 mmHg in the SLT group (level II evidence). After treatment, the mean number of medications that lower IOP was decreased in both groups.

How Does Laser Trabeculoplasty Compare with Alternative Forms of Medical or Surgical Therapy in Lowering Intraocular Pressure?

In the Glaucoma Laser Trial,[26,34] initial laser trabeculoplasty lowered IOP more (decrease of 9 mmHg) than initial treatment with topical timolol maleate (decrease of 7 mmHg) over 2 years; initial laser trabeculoplasty was at least as effective in preserving visual field and optic disc status over 5.5 years (level I evidence). In the Glaucoma Laser Trial, medication was initiated or changed after the initial treatment if the IOP was not controlled. For patients with newly diagnosed POAG enrolled in the Moorfields Primary Treatment Trial, trabeculectomy lowered IOP the most (decrease of 60%). The laser trabeculoplasty (decrease of 38%) and medical therapy groups (decrease of 49%) had more deterioration in visual fields than the trabeculectomy group (level I evidence).[35]

A randomized comparison of SLT and topical medication for patients with POAG or ocular hypertension found no significant differences in lowering IOP in 5 years of follow-up, although the SLT group had fewer medications (level II evidence).[36] In a study of 40 patients with POAG randomized to treatment with topical latanoprost or SLT, both groups achieved similar success in IOP reduction at 4 to 6 months, but latanoprost was more successful in controlling IOP fluctuations (P = 0.04, level II evidence).[37] A comparison of SLT with treatment with topical latanoprost for patients with newly diagnosed POAG found no significant difference in lowering IOP over 12 months of follow-up (level II evidence).[38]

Are There Meaningful Differences in Safety or Outcomes Between Various Lasers?

The Cochrane systematic review of laser trabeculoplasty concluded that there was some evidence showing similar effects in IOP control for diode and selective laser trabeculoplasty compared with ALT at 6 months and 1 year of follow-up (level I evidence).[24]

In a comparison of SLT and ALT, Damji et al[39] found no significant difference in lowering IOP or in early or late complications rates between the groups at 1 year (level I evidence). A randomized comparison of MDLT and ALT with 3 months of follow-up found that the mean IOP decrease was 2.5$\pm$2.6 mmHg for the MDLT group and 4.9$\pm$3.4 mmHg for the ALT group (P = 0.04, level II evidence).[40] A comparison of SLT and ALT in patients with uncontrolled open-angle glaucoma taking maximally tolerated medication therapy with a follow-up of 12 months found no statistically significant difference in lowering IOP between the groups.[41] Patients in the study whose IOP was more than 20 mmHg at 3 months underwent a randomly assigned repeat treatment. Patients who received SLT as a repeat treatment had a statistically significant difference in lowering IOP compared with ALT treatment (6.24 mmHg and 4.65 mmHg, respectively; $P<0.01$, level II evidence).[41] A comparison of titanium-sapphire laser trabeculoplasty and ALT found similar reduction in IOP from preoperative levels in both groups, with a mean follow-up period of 15 months (level III evidence).[42]

The most common complication of laser trabeculoplasty is a transient rise in the IOP, which has been reported in 12% (>10 mmHg) to 34% (>5 mmHg) of patients after ALT.[43] Diode laser trabeculoplasty[19] and SLT[43] have transient IOP increases similar to those associated with ALT.

A low-grade iritis may follow laser trabeculoplasty, but it does not clearly impact efficacy. There is evidence that inflammatory mediators account for this response to laser trabeculoplasty.[9,11] Rarely, corneal burns and reflux bleeding from the meshwork (Schlemm's) may be noted.

To What Degree Is Laser Trabeculoplasty Repeatable?

Repeat ALT after an initially successful ALT treatment has had reported success rates of 21% to 70% at 1 year (level III evidence).[44–50] In a study with longer follow-up, success rates were reported as 11% at 24 months and 5% at 48 months.[45] No eyes that received repeat ALT less than 12 months after the initial ALT were successful at 1 year after the second treatment.[45]

In a study to determine repeatability of SLT, Hong et al[51] studied 44 eyes of 35 patients with open-angle glaucoma that was uncontrolled with maximum tolerated medical therapy (level III evidence). The eyes underwent an initial 360° SLT (first SLT treatment) that was successful for more than 6 months, but eventually lost efficacy and was followed by a second 360° SLT (second SLT treatment). Patients with prior ALT or other glaucoma surgery were excluded from the study. Intraocular pressure was recorded before each procedure and at 1 to 4 weeks, 1 to 3 months, and 5 to 8 months after treatment. Both the first and second treatments significantly reduced the IOP at the 1- to 3-month pressure check by 5.0 mmHg and 2.9 mmHg, respectively ($P = 0.01$), but there were no statistically significant differences between treatments at other time points. Using a definition of success of 20% reduction in IOP, the success of the first and second treatments were not significantly different. There was no difference in efficacy outcomes between eyes that received SLT 6 to 12 months after the first treatment compared with those that received a second treatment at more than 12 months.

Conclusions

Laser trabeculoplasty is successful in lowering IOP based on level I evidence for ALT and level II evidence for DLT and SLT. The duration of treatment effect varied in the studies, and comparisons are difficult, because the patient populations, definitions of successful treatment, and length of follow-up are different. There is level II evidence that SLT and topical medications currently used have a similar effect in lowering IOP. The IOP-lowering effect and complications of treatment are similar for DLT and SLT compared with ALT based on level I evidence, they are similar for MDLT and ALT based on level II evidence, and they are similar for titanium-sapphire laser trabeculoplasty and ALT based on level III evidence. Determinations on the repeatability of laser trabeculoplasty are based on level III evidence, with a wide range of success reported for ALT. There is some evidence that eyes that receive repeat ALT within 12 months of the initial treatment will require further intervention more quickly than eyes with an initial success of more than 12 months. One case series reported similar effects of IOP lowering on first and second SLT and no difference in efficacy outcomes when the retreatment occurred earlier than 12 months compared with later than 12 months. At present, there is no literature that establishes a clear clinical superiority of any one type of laser for trabeculoplasty.

Further Research

Highly powered studies that may show differences in the lasers have not yet been performed, but it is possible that there are differences in outcome related to duration or repeatability in the various types of lasers. It is not clear whether the theoretical advantages that the newer lasers offer—of not heating tissue and penetrating into deeper layers of the trabecular meshwork—can be translated into actual clinical advantage. Also, the issue of whether trabeculoplasty is more effective in patients who have not been treated with glaucoma medication has not been addressed adequately. There may be pharmacologic methods that could enhance the response to trabeculoplasty. The appropriate amount of laser energy to elicit an optimal clinical response needs further study.

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