



Research Paper

The effectiveness of patterned laser trabeculoplasty over 6 months period: A cohort study

Khalid Al Zubi*, Khalil Alsalem

Ophthalmology and Visual Sciences Department, Mutah University, Al-Karak, Jordan

ARTICLE INFO

Article history:

Received 18 October 2018

Received in revised form

7 December 2018

Accepted 16 December 2018

Available online 21 December 2018

Keywords:

Patterned laser trabeculoplasty

Patients

Glaucoma

Intraocular pressure

ABSTRACT

Introduction: To evaluate the efficacy of pattern laser trabeculoplasty (PLT) as a treatment for lower intraocular pressure among patients with primary open-angle glaucoma.

Methods: Cohort case study has been used as the study design. A total of 85 patients with bilateral open-angle glaucoma underwent bilateral pattern laser trabeculoplasty (PLT) to reduce intraocular pressure (IOP). The initial and consequent intraocular pressure of all the patients was evaluated at 3 months and 6 months. IOP results were compared before treatment and after 3 and 6 months of receiving treatment, using the paired T-test.

Results: The average intraocular pressure in the right eye was decreased from the pre-treatment level at 22.1 mm hg (+/- 0.78) to 18.8 mm hg (+/- 0.83), after six months following the treatment. It represented a 14.9% reduction of average intraocular pressure, which is statistically significant with a P-value 0.036, using Paired T-Test. On the contrary, the average intraocular pressure in the left eye decreased from the pre-treatment level at 22.7 mm hg (+/- 0.62) to 19.2 mm hg (+/- 0.80), representing 15.4% reduction of the average intraocular pressure.

Conclusion: The results have shown that pattern laser trabeculoplasty is a potential useful tool in treating open angle glaucoma.

© 2019 The Authors. Published by Elsevier Ltd on behalf of Surgical Associates Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

Laser trabeculoplasty (LTP) was introduced by Worthen and Wickham in 1973 which is an argon laser used to perform trabeculoplasty, gonio punctures or laser puncture. It was not until 1979 that Wise and Witter described a modified technique to perform Argon Laser Trabeculoplasty (ALT), which subsequently gained acceptance as a therapeutic option of Open-Angle Glaucoma (OAG) [1]. At that time; the procedure was considered to be the last alternative to topical treatment before undergoing Glaucoma surgeries. Selective Laser Trabeculoplasty (SLT) was listed as a procedure separate from ALT by FDA in 2002. SLT is considered as the delivery of laser energy to TM using parameters, which selectively absorb energy by pigmented cells. The specific energy spares adjacent cells and tissues from thermal damage. Few studies have shown that thermal injury is common with high energy ALT. The later fact forced experts to use SLT instead of ALT [2,3]. Unlike ALT,

another good advantage of SLT is its ability to repeat the procedure more than once if needed for the same eye.

Due to the problems associated with the conventional treatment modalities, the novel pattern scan laser (PASCAL) photocoagulation using a shorter pulse duration was introduced, in 2005 by Opti-Medica (Santa Clara, CA). PLT caused reduction in the unexpected retinal injuries and allowed easier and less time-consuming application of laser [4,5]. PASCAL photocoagulation caused less collateral damage that resulted in similar regression of diabetic retinopathy as compared to conventional PRP [6]. The study aims to assess the usefulness of PASCAL in trabeculoplasty and evaluates the reduction of intraocular pressure over 6 month's periods after treatment. There are several clinical implications of Pattern Scan Laser Trabeculoplasty (PLT) due to its effectiveness and safety profile as compared to other treatment modalities. It can be effectively used for the anterior and posterior segments photocoagulation. This includes: the photocoagulation of focal retinal and choroid structural abnormalities, central retinal vein occlusion, retinal degeneration, and proliferative and non-proliferative diabetic retinopathy. The parameters associated with PLT are safe and; therefore, it is referred to as an effective method for the treatment

* Corresponding author.

E-mail address: dr_khalidzu@yahoo.com (K. Al Zubi).

of open-angle glaucoma. Moreover, this technique poses less complications and adverse impacts on the overall retinal health of the patients, which accounts for its preference over other treatment modalities.

2. Material and methods

An interventional cohort study was conducted at Eye Specialty hospital, Amman, Jordan that recruited 85 participants. Ethics approval was granted by the ethics committee at Mutah University, and all patients signed informed consent documents. All participants had a thorough medical examination regarding their Glaucoma, which included baseline visual acuity, intraocular pressure by Goldman applanation tonometer, and visual field assessment. The patients were kept on their glaucoma medications without altering them all throughout the study period. The changes in vision and intraocular pressure were documented at 0, 3, and 6 months after treatment.

Bilateral Pattern scan laser was applied to trabecular meshwork among all the patients, diagnosed with open angle Glaucoma. Bilateral Pattern scan laser (Nd: YAG diode pumped solid state laser-532 nm), 50 spots of 50 micro-m diameter over 180° of pigmented part of trabecular meshwork was done, power was titrated to blanching effect with pulse duration of 10 ms [7,13]. Later, the duration was reduced to 5 ms, and same power was used during the whole procedure. All patients were given their anti-glaucoma medication after the procedure with steroid eye drops for a couple of weeks. Informed consent was obtained from each of the subjects in accordance with the principles outlined in the declaration of Helsinki. The privacy of health information was maintained as stated in the health insurance portability and accountability act.

The 5-ms pulses are invisible while using the pattern scan laser for retinal photocoagulation at 10-ms to produce faint burns. The present study has used similar principle in performing the

treatment. The power was titrated at the beginning of treatment to see a slight blanching of trabecular meshwork at 10-ms, after that the laser duration was reduced to 5-ms using the same power. Statistics was performed using SPSS (Version17.0; SPSS Inc., Chicago, IL, USA). The visual acuity (in log Mar), age, intraocular pressure in mmHg, and number of medications used over 0, 3, and 6 months period were inserted as scale measure. Meanwhile, the gender was inserted as nominal. Paired T-Test was used to compare the means between the intraocular pressure between 0, 3, and 6 months, after laser trabeculoplasty.

3. Results

Almost all of the patients were available at 6 months. The results have shown that the mean age of the patients was 76.55 years (+/-2.38). The mean right eye visual acuity in log Mar before treatment was 0.28+/-0.15. The mean left eye visual acuity in the log Mar before treatment was 0.26+/-0.15. The mean baseline intraocular pressure in the right eye was 22.1+/-0.78 mm Hg, and the mean baseline intraocular pressure in the left eye was 22.7+/-0.62 mm Hg. The average intraocular pressure in the right eye was decreased from the pre-treatment level at 22.1 mm hg (+/- 0.78) to 18.8 mm hg (+/- 0.83), after six months following the treatment. It represented a 14.9% reduction of average intraocular pressure, which is statistically significant with a P- value 0.036, using Paired T-Test (Tables 1 and 2). Whereas, the average intraocular pressure in the left eye decreased from the pre-treatment level at 22.7 mm hg (+/- 0.62) to 19.2 mm hg (+/- 0.80). It represented 15.4% reduction of the average intraocular pressure, which is also statistically significant with a p-value of 0.012 using paired T-Test. It clearly showed that pattern scan laser is an effective tool for treating open angle glaucoma, knowing that the laser has been applied to 180° of the trabecular meshwork circumference only.

Table 1
Paired samples statistics.

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	IOP_0_R	22.1	85	0.04322	.78301
	IOP_6_R	18.8	85	0.23539	.83420
Pair 2	IOP_0_L	22.7	85	0.13645	.62346
	IOP_6_L	19.2	85	0.93097	.80089
Pair 3	IOP_0_R	22.1	85	0.04232	.78301
	IOP_3_R	18.8	85	0.68899	.94021
Pair 4	IOP_0_L	23.4	85	0.34615	.62346
	IOP_3_L	20.2	85	0.27453	.81872
Pair 5	IOP_6_R	21.2	85	0.52339	.83420
	IOP_3_R	19.3	85	0.68899	.94021
Pair 6	IOP_6_L	23.0	85	0.09739	.80089
	IOP_3_L	14.2	85	0.27345	.81872

IOP: intraocular pressure, 0 month (preoperative), 3, 6 months.
R: right eye, L: left eye.

Table 2
Correlation between baseline and final IOP.

		N	Correlation	Sig.
Pair 1	IOP_0_R & IOP_6_R	85	.762	.036
Pair 2	IOP_0_L & IOP_6_L	85	.771	.032
Pair 3	IOP_0_R & IOP_3_R	85	.677	.012
Pair 4	IOP_0_L & IOP_3_L	85	.319	.556
Pair 5	IOP_6_R & IOP_3_R	85	.413	.039
Pair 6	IOP_6_L & IOP_3_L	85	.551	.430

IOP: intraocular pressure, 0 month (preoperative) 3, 6 months.
R: right eye, L: left eye.

4. Discussion

Laser trabeculoplasty has been performed in different protocols to achieve a significant drop in intraocular pressure. In SLT, the used energy is much lower than that used in other modalities due to the different mechanisms of cellular damage produced by nanosecond and millisecond pulses. Denaturation of proteins and other cellular macromolecules is the main mechanism of cellular damage in millisecond pulses. Whereas, cavitation bubbles forming around melanosomes are the main mechanism of cellular damage in nanosecond pulses [8]. Therefore, the heat in nanosecond pulses is unlikely to diffuse beyond one micrometer, which means that the damage can be very limited. Whereas, in five millisecond pulses, the heat is more likely to diffuse to around 50 μm distances and affect cells surrounding the pigmented structures. The actual structural and cellular damage to the trabecular meshwork produced by sub-visible 5-ms pulses need to be evaluated in further studies.

A study described the preliminary clinical evaluation of laser trabeculoplasty, which is known as a novel computer guided laser treatment for treating open angle glaucoma. The results showed that this treatment provides rapid treatment that is minimally traumatic and depicted 31% reduction in the intraocular pressure after 6 months [9]. Another study investigated the change in patterns of intraocular pressure before and after laser trabeculoplasty in cats. The results depicted that laser treatment was successful in producing significant reduction in intraocular pressure, which was accompanied by dampened amplitude of the nycthemeral rhythm among the patients [10]. These results confirmed the relevance of continuous monitoring of 24-hour intraocular pressure related patterns in the accurate evaluation of different glaucoma treatments.

Although laser trabeculoplasty is an effective treatment, its uniformity is not effective in all the eyes and its intraocular pressure lowering effect tend to decrease with time [11]. A study compared the safety and efficacy of laser trabeculoplasty in lowering intraocular pressure among glaucoma patients. The results showed adequate safety and efficacy profiles for being treated with laser trabeculoplasty [12]. This treatment decreases any additional medical therapy among glaucoma patients and is considered as an auxiliary therapy for tolerating the maximal medical therapy given before undergoing surgical intervention [13].

There is decrease in the frequency of trabeculoplasty; although, the prevalence of glaucoma has been increasing because the patients fail to comply with the reliability of instilling eye drops [14]. Different laser techniques including the pattern scanning trabeculoplasty have helped in reducing the intraocular pressure and burden that is caused by glaucoma medical therapy. The technique is likely to provide a more favorable safety profile with fewer complications, including post laser inflammation and IOP spikes [15]. A study compared the efficacy of laser trabeculoplasty with previously used incisional glaucoma surgery and found that laser trabeculoplasty results in similar IOP reductions [16]. The study found similar IOP reduction with and without prior glaucoma surgery.

Selective Laser Trabeculoplasty (SLT) is a new treatment, which includes a different type of laser as compared to Argon Laser Trabeculoplasty (ALT) for treating open-angle glaucoma (OAG). IOP spikes are relatively not seen in the treatment procedure carried out with ALT [17]. Moreover, another study conducted by Polat et al. [18] confirmed the efficiency of SLT for the treatment of open-eye glaucoma (OAG). The study suggested that the repeated procedure of SLT can result in restoration of IOP control in eyes, affected by OAG. In the study conducted by Miraftabi et al. [19] compared the efficacy of single-session 360-degree SLT for reduction of IOP in

patients suffering from pseudoexfoliative glaucoma (PXFG) and primary open-angle glaucoma (POAG). The results of the study were found to be significant i.e. 360-degree SLT is an adequate and effective method for the treatment of POAG and PXFG without causing reduction in the number of medications given to the patients. Moreover, the study showed that the effectiveness of SLT reduced gradually with time and this was more prominent among PXFG patients.

Another efficient technique used for the treatment of open-eye glaucoma (OAG) is pattern scan laser trabeculoplasty (PLT). The safety and efficacy procedure of PLT was discussed in the study conducted by Espinoza et al. [20]. The results of the study concluded that PLT is a safe and effective method for the treatment of OAG. Moreover, PLT is an adjunctive therapy that is utilized for the treatment of open-angle glaucoma (OAG). The study evaluated the short-term stability of the following technique; therefore, larger studies must be designed to identify the long-term stability of laser technology for reducing the intraocular pressure.

5. Conclusions

Pattern laser trabeculoplasty (PLT) is an effective and safe method for the treatment of open-angle glaucoma (OAG). PLT is an important breakthrough in the field of laser treatment. Retinal conditions of patients can be significantly treated with PLT. Apart from treating glaucoma, PLT can also be used for the treatment of short pulse durations result in less heat diffusion to the inner retina and choroid. The treatment is less painful as compared to other treatment modalities. Average reduction of 14.9% in the intraocular pressure of right eye was recorded after six months following the treatment. Moreover, average reduction of 15.4% in the intraocular pressure of left eye was recorded after six months following the treatment. The results of the study showed that pattern scan laser trabeculoplasty can be used as an effective tool for the treatment of glaucoma.

The follow-up procedure for the current study was limited to 6 months, which serves as an impediment to analyze adequate and accurate results. Moreover, the number of patients also gradually reduced during the 6-month period, due to which the study was conducted on small sample size. It is important to conduct long-term studies to identify the time period for the loss of IOP control and to significantly analyze the efficacy and safety procedure required for SLT to be used repeatedly as a treatment procedure for open-angle glaucoma. Long-term studies are required to justify accurately the benefits of PLT over time and its effectiveness in reducing intraocular pressure (IOP). Therefore, a study with extended follow up time depicting changes in medication use or success rates must be conducted to examine the extent and the long-term stability of the intraocular pressure reduction.

Ethical approval

Ethics approval was granted by the ethics committee at Mutah University (number 20179), and all patients signed informed consent documents.

Funding

This research is not associated to any funding source.

Author contribution

Khalid Al Zubi is the corresponding author of the manuscript and responsible for study concept or design, data collection, data analysis or interpretation, writing the paper and finalization.

Khalil Alsalem was responsible for data collection, data analysis or interpretation, writing the paper.

Conflict of interest statement

The authors declare no conflict of interest.

Guarantor

Khalid Al Zubi is the Guarantor of the research.

Research registration number

N/A.

Acknowledgements

The author is very thankful to all the associated personnel in any reference that contributed in/for the purpose of this research.

References

- [1] Wise JB, Witter SL. Argon laser therapy for open-angle glaucoma: a pilot study. *Arch Ophthalmol* 1979;97:319–22. <https://doi.org/10.1001/archoph.1979.01020010165017>.
- [2] Lee JW, Fu L, Chan JC, Lai JS. Twenty-four-hour intraocular pressure related changes following adjuvant selective laser trabeculoplasty for normal tension glaucoma. *Medicine* 2014;93.
- [3] Kramer TR, Noecker RJ. Comparison of the morphologic changes after selective laser trabeculoplasty and argon laser trabeculoplasty in human eye bank eyes. *Ophthalmology* 2001;108:773–9. [https://doi.org/10.1016/s0161-6420\(00\)00660-6](https://doi.org/10.1016/s0161-6420(00)00660-6).
- [4] Velez-Montoya R, Guerrero-Naranjo JL, Gonzalez-Mijares CC, Fromow-Guerra J, Marcellino GR, Quiroz-Mercado H, et al. Pattern scan laser photocoagulation: safety and complications, experience after 1301 consecutive cases. *Br J Ophthalmol* 2010;94:720–4. <https://doi.org/10.1136/bjo.2009.164996>.
- [5] Ye H, Jin C, Zhong X, Tian Z, Lin W. Pattern scan laser photocoagulator on retinopathy: an annual clinical application summary 2016;26:70–4.
- [6] Nagpal M, Marlecha S, Nagpal K. Comparison of laser photocoagulation for diabetic retinopathy using 532-nm standard laser versus multispot pattern scan laser. *Retina* 2010;30:452–8. <https://doi.org/10.1097/iae.0b013e3181c70127>.
- [7] Turati M, Gil-Carrasco F, Morales A, Quiroz-Mercado H, Andersen D, Marcellino G, et al. Patterned laser trabeculoplasty. *Ophthalmic Surg Laser Imag Retina* 2010;41:538–45. <https://doi.org/10.3928/15428877-20100910-02>.
- [8] Schuele G, Rumohr M, Huettmann G, Brinkmann R. RPE damage thresholds and mechanisms for laser exposure in the microsecond-to-millisecond time regimen. *Investig Ophthalmol Vis Sci* 2005;46:714–9. <https://doi.org/10.1167/iovs.04-0136>.
- [9] Thomas F. Patterned laser trabeculoplasty. *Ophthalmol Times* 2013 Jul;38–9.
- [10] Lee JY, Ha SY, Paik HJ, Kwon KY, Kim YY. Morphologic changes in trabecular meshwork after patterned and argon laser trabeculoplasty in cats. *Curr Eye Res* 2014;39:908–16. <https://doi.org/10.3109/02713683.2014.884596>.
- [11] Leahy KE, White AJ. Selective laser trabeculoplasty: current perspectives. *Clin Ophthalmol* 2015;9:833.
- [12] Mansouri K, Shaarawy T. Comparing pattern scanning laser trabeculoplasty to selective laser trabeculoplasty: a randomized controlled trial. *Acta Ophthalmol* 2017;95:e361–5. <https://doi.org/10.1111/aos.13280>.
- [13] Min JK, Yim JH. Pattern laser trabeculoplasty intraocular pressure reduction efficacy in open-angle glaucoma patients on medical therapy. *J Kor Ophthalmol Soc* 2013;54:1862–7. <https://doi.org/10.3341/jkos.2013.54.12.1862>.
- [14] Milano G, Vercellin AC, Lombardo S. Safety and efficacy of the computer guided patterned selective laser trabeculoplasty (PSLT). *Investig Ophthalmol Vis Sci* 2016;57:6482.
- [15] Tsang S, Cheng J, Lee JW. Developments in laser trabeculoplasty. *Br J Ophthalmol* 2015;100(1):94–7. <https://doi.org/10.1136/bjophthalmol-2015-307515>.
- [16] Sharpe RA, Kammerdiener LL, Williams DB, Das SK, Nutaitis MJ. Efficacy of selective laser trabeculoplasty following incisional glaucoma surgery. *Int J Ophthalmol* 2018;11:71.
- [17] Kent SS, Hutnik CM, Birt CM, Damji KF, Harasymowycz P, Si F, et al. A randomized clinical trial of selective laser trabeculoplasty versus argon laser trabeculoplasty in patients with pseudoexfoliation. *J Glaucoma* 2015;24:344–7. <https://doi.org/10.1097/ijg.0b013e31829e55e4>.
- [18] Polat J, Grantham L, Mitchell K, Realini T. Repeatability of selective laser trabeculoplasty. *Br J Ophthalmol* 2016 Oct;100(10):1437–41. Epub 2016 Feb 1. <https://doi.org/10.1136/bjophthalmol-2015-307486>.
- [19] Miraftebi A, Nilforushan N, Nassiri N, Nouri-Mahdavi K. Selective laser trabeculoplasty in patients with pseudoexfoliative glaucoma vs primary open angle glaucoma: a one-year comparative study. *Int J Ophthalmol* 2016;9:406.
- [20] Espinoza G, Castellanos L, Rodriguez-Una I, Camacho PA, Parra JC. Clinical outcomes of patterned laser trabeculoplasty as adjuvant therapy in open angle glaucoma and ocular hypertension. *Int J Ophthalmol* 2018;11:635.