



## RESEARCH ARTICLE

## Selective Trabeculoplasty in the Management of Open Angle Glaucoma: Retrospective Analysis at 1 Year

Mathilde Boiché<sup>1</sup>, Jean Baptiste Conart<sup>1</sup>, Amandine Luc<sup>2</sup>, Cédric Baumann<sup>2</sup>, Karine Angioi<sup>1</sup> and Toufic Maalouf<sup>2\*</sup>

<sup>1</sup>Department of Ophthalmology, Nancy-Brabois University Hospital, France

<sup>2</sup>Platform of Clinical Research Support (Plateforme d'aide à la recherche clinique, PARC), Nancy-Brabois University Hospital, France



\*Corresponding author: Toufic Maalouf, Department of Ophthalmology, Nancy-Brabois University Hospital, Rue du Morvan, 54500 Vandoeuvre les Nancy, France, Tel: +3-33-83-15-30-29, Fax: +3-33-83-15-51-09, E-mail: [t.maalouf@chru-nancy.fr](mailto:t.maalouf@chru-nancy.fr)

### Abstract

**Purpose:** The objective of this study was to observe the 1-year pressure gain in a consecutive series of glaucoma patients treated by selective laser trabeculoplasty, along with the clinical and technical characteristics that influence the evolution of intraocular pressure after treatment.

**Materials and methods:** We carried out a retrospective study of all patients treated in the ophthalmology department of Nancy University Hospital between January 2015 and March 2016. Treatment was performed with a Q-Switched, frequency doubled Nd: YAG laser (Solutis - Quantel Medical, France), over 180° or 360° of the trabecular meshwork. The mean decreases in Intraocular pressure and the success rate (defined as a decrease in intraocular pressure of ≥ 20% at 1 year without increasing the medical treatment) were calculated. The impact of the different clinical and technical characteristics of each case on the decrease in pressure was also studied by bivariate analysis.

**Results:** One hundred and nineteen eyes, in 78 patients, were included. The decrease in IOP at 1 year was in mean of 4.2 mmHg (Standard Deviation = 5.37), and of 19.6% from baseline. The success rate was 46.7%. Only two minor and reversible complications occurred during the follow-up period.

**Discussion:** Selective trabeculoplasty is currently a therapeutic option called-upon at different stages in the progression of glaucoma. The duration of efficacy of this laser therapy, and the retreatment frequency are yet to be defined.

### Keywords

Open angle glaucoma, Selective trabeculoplasty, Laser

### Introduction

In order to prevent the progressive and irreversible loss of optic nerve fibres, the treatment of glaucoma aims to effectively and lastingly reduce Intraocular Pressure (IOP) in affected patients. To this end, in addition to medical and surgical techniques, means of weakening the trabeculum by laser have been developed since the 1980s, following the pilot study by Wise and Witter [1].

The procedure was originally performed using an argon laser. Impacts of 50 µm diameter were applied to the pigmented trabeculum, using wavelengths between 488 and 514 nm with high fluence levels (energy/area) [2,3].

The Latina study, which reported the possibility of targeting only the pigmented cells of the trabeculum using a selective laser delivering low-fluence spots, made possible the development of Selective Laser Trabeculoplasty (SLT) in 1998 [4,5].

This technique uses a Q-Switched, frequency doubled Nd: YAG laser with a wavelength of 532 nm. The impact spot size and duration of the pulses are fixed, respectively 400 µm and 4 ns. The energy level is variable and can be set to values from 0.2 to 2.0 mJ. The energy required to perform SLT is less than 1% than the one used with argon laser trabeculoplasty [6]. Its sub-threshold treatment parameters and its wavelength of 532 nm, highly absorbed by melanin, have the advan-

tage of targeting the pigmented cells of the trabeculum without generating heat and thus are not damaging surrounding tissues, preserving the trabecular meshwork architecture [2,7].

The reduction in IOP after SLT may be explained, besides the mechanical opening of the trabeculum and the canal of Schlemm, by cellular and biochemical mechanisms favouring the drainage of the aqueous humour [8,9].

The aim of our study was to observe the 1-year pressure gain in a consecutive series of glaucoma patients following SLT laser treatment, as well as the clinical and technical characteristics that may have an impact on the efficacy of the treatment.

## Materials and Methods

### Design

We carried out a retrospective study including all glaucoma patients having received SLT laser treatment in the ophthalmology department of the Nancy University Hospital between January 2015 and March 2016.

### Sample

The inclusion criteria were as follows, patients over 18 years of age, with open-angle glaucoma, with uncontrolled IOP or intolerance to topical drug therapy, including certain patients for whom the laser was proposed as first-line treatment in order to best preserve their ocular surfaces. The patients had to have an open irido-corneal angle in order to allow the laser treatment implementation (chronic primary open-angle glaucoma, pseudo-exfoliative or pigmentary glaucoma, post-traumatic glaucoma and corticosteroid-induced glaucoma). Patients under the age of 18 were excluded from the study, as were patients who had Already undergone Laser Trabeculoplasty (ALT or SLT) in the past. Both eyes could be included.

### Data collection

For each patient we recorded the following characteristics: Age, ethnicity, sex, side treated (left/right), type of glaucoma, irido-corneal angle pigmentation (grade 0 to 4 according to the Scheie classification [10]) pachymetry and history of filtration surgery.

We also observed the following parameters before treatment, at the first follow up consultation and at 1 year: IOP (Goldmann Applanation Tonometer), number of topical hypotonicity-inducing molecules.

When OCT imaging was performed, Retinal Nerve Fiber Layer (RNFL) and macular ganglion cell complex thickness measurements were collected and when visual field follow-up was available, the Mean Deviation (MD) and Pattern Standard Deviation (PSD) were also recorded.

The treatment was carried out under topical anaes-

thesia with oxybuprocaine hydrochloride 0.4% and using a Latina contact lens or a 3-mirror lens. A SLT laser manufactured by Quantel Medical, France (Solutis laser), delivering impacts from 0.2 mJ to 2.0 mJ was used for the treatment. The energy was titrated prior to laser treatment. The first impacts on the trabeculum were performed at low energy, and the energy level was increased until a vaporization bubble formation appeared upon impact.

The treatment was then performed over 180° or 360° (at the physician's discretion), with some fifty impacts per hemi-circumference. The treatment settings used were recorded for each patient (energy level and circumference treated: 180° or 360°).

Preoperative hypotonic treatment was continued and a topical NSAID treatment was prescribed for 10 days after the laser session.

Minor and major side effects were reported.

### Statistical analysis

The primary endpoint of the study was the evaluation of the pressure gain at 1 year. Treatment success was defined as a one-year decrease in pressure greater than or equal to 20% of baseline with no increase in medical treatment.

The non-parametric signed Wilcoxon test was used to compare the means, the Kruskal-Wallis test for the analysis of qualitative variables and a simple linear regression model for the quantitative variables. A p-value less than 0.05 were considered significant.

## Results

We included 119 eyes of 78 patients (ethnicity: 76 Caucasian and 2 Hispanic). The clinical characteristics of the patients at baseline and the technical characteristics of the SLT laser treatment are described in [Table 1](#) and [Table 2](#).

The decrease in IOP at 1 year was statistically significant, with an average gain of 4.2 mmHg (SD = 5.37), i.e. an average decrease in IOP of 19.6%. The treatment success rate was 46.7% in our study, [Table 3](#) and [Table 4](#). The decrease in the number of hypotonicity-inducing molecules used was not significant.

The bivariate analysis of the impact of different clinical parameters on the decrease in IOP at 1 year revealed no statistical link for age, sex, side treated (left or right), pachymetry, prior filtration surgery or the number of pre-laser topical treatments. The impact of the type of glaucoma, angle pigmentation and laser energy could not be evaluated due to lack of sufficient numbers.

The only parameter having a significant impact in our study was the irido-corneal angle circumference treated: The decrease in pressure was greater when the trabeculum was treated over 180° than when it was

**Table 1:** Pre-laser characteristics.

	n	%/mean	SD	min	max
<b>Number of eyes</b>	119	62.0	12.0	23.0	89.0
<b>Age</b>					
<b>Sex</b>					
F	59	49.6			
M	60	50.4			
<b>Side</b>					
R	65	54.6			
L	54	45.4			
<b>Open Angle Glaucoma type</b>					
Primary	105	88.2			
Pigmentary	5	4.3			
Pseudo-exfoliative	1	0.9			
Post-traumatic or post-surgical	4	3.4			
Corticosteroid induced	4	3.4			
<b>Pigmentation of the irido-corneal angle</b>					
0	2	3.8			
1	11	21.2			
2	27	51.9			
3	9	17.3			
4	3	5.8			
<b>Pachymetry</b>		542.0 (µm)	43.7	410.0	630.0
<b>Number of filtration surgery interventions pre-laser</b>					
0	109	91.6			
1	7	5.9			
2	2	1.7			
3	1	0.8			
<b>Average number of topical treatments pre-laser</b>		2.3 (molecules)	1.0	0.0	4.0
<b>IOP pre-laser</b>		20.0 (mmHg)	5.0	11.0	42.0
<b>Mean follow-up period</b>		10.7 (months)	3.1		

**Table 2:** Technical characteristics of laser SLT treatment.

	n	%
<b>Trabeculum circumference treated</b>		
180°	24	23.3
360°	79	76.7
<b>Laser energy (mJ)</b>		
0.8	2	2.7
1.2	39	52.0
1.3	10	13.3
1.5	17	22.7
2	7	9.3

treated over 360° ( $p = 0.0024$ ). The average gain of IOP in patients treated over 180° was 7.2 mmHg and it was 2.9 mmHg in the group treated over 360°.

In the year following the SLT, filtration surgery was required for 8 eyes.

Only two minor side effects were reported in our series, one case of visual blurring sensation and one decrease in visual acuity by pigment dispersion, occurring immediately after the laser treatment, and both resolving spontaneously.

## Discussion

The place of SLT in the management of glaucoma is an additional contribution to the therapeutic arsenal since it can supplement topical drug therapy when the latter is insufficient, poorly tolerated or where self-treatment

**Table 3:** IOP evolution.

	%/mean	SD
IOP pre-laser (mmHg)	<b>20</b>	5
IOP at 1 year (mmHg)	<b>15.3</b>	4.6
Decrease in IOP at 1 year (%)	<b>-19.6%</b>	22.5
Success rate	<b>46.7%</b>	

compliance is poor (problems with understanding, difficulty instilling drops, forgetting to self-treat). When performed in addition to maximal medical treatment, it also allows surgery for uncontrolled glaucoma to be delayed. It is ever more frequently proposed as a first-line treatment in newly diagnosed patients, because of its preservation of the ocular surface on the one hand and the economic gain on the other [11,12]. Katz, et al. found no difference between SLT treatment and drug treatment in the initial management of OAG [13].

Sayin, et al. report success rate of 64.5% at 1 year [14], Hodge, et al. 60% [15], Kontic, et al. 64.58% [16] and Damji, et al. 59.7% [17,18]. The success rate in our study, at 46.7%, is somewhat lower than those reported in the literature. This is probably due to our recruitment, given that we did not exclude patients in advanced stages of the disease or those with a history of filtration surgery. The various prospective and retrospective studies carried out on the efficacy of laser SLT at one year report a percentage reduction in IOP between 16.9 and 31.6% of baseline [9], consistent with our 19.6% decrease in IOP.

**Table 4:** Comparison of parameters pre-laser and at 1 year.

	<b>N (number of patients with available data)</b>	<b>Change between T1 and T0 mean (SD)</b>	<b>p-value</b>
<b>Number of topical treatments</b>	97	-0.11 (0.77)	0.240
<b>IOP (mmHg)</b>	<b>97</b>	<b>-4.2 (5.37)</b>	<b>&lt; 0.0001</b>
<b>MD (dB)</b>	32	-0.54 (1.50)	0.0336
<b>PSD (dB)</b>	20	-0.71 (1.47)	0.0532
<b>RNFL (<math>\mu</math>m)</b>	48	-0.96 (2.94)	0.0176
<b>Ganglion cell complex (<math>\mu</math>m)</b>	9	-0.22 (1.71)	0.844

We showed no reduction in the number of topical treatments at 1 year in our study, which can also be explained by our own recruitment at the Nancy University Hospital, where patients monitored for glaucoma are often difficult to stabilise. The aim in these patients was to decrease IOP even further, in order to preserve visual function. The initial medical treatment was continued after SLT in all of these patients. Moreover, the short duration of follow up did not make it possible to demonstrate whether one or more molecules were discontinued some time after laser treatment. In a 12-year post-laser retrospective analysis of 28 patients, Giocanti, et al. reported a reduction in the use of topical treatment in 58.4% of patients [2]. In another randomised prospective study comparing medical treatment alone and laser SLT as adjuvant therapy, Lee, et al. demonstrated that the SLT-treated group required significantly fewer topical treatments than before their laser treatment [19].

We found a significant difference between the treatment circumference and the decrease in IOP at 1 year. Patients treated over 180° had a greater decrease in pressure than patients treated over 360°. This surprising difference would probably not have been found in a larger sample. Goyal, et al. [20] and Nagar, et al. [21] found no difference between the two treatment circumferences at 1 month and 12 months. In a retrospective study of 35 eyes, Shibata, et al. found greater efficacy when treating the trabeculum over its full circumference [22].

In terms of visual field and OCT parameters, relative stability is observed with minimal degradation of MD and RNFL in patients with chronic pathologies. The one-year follow up time is too short to draw any definitive conclusions.

In the literature, other factors seem to have an impact on the efficacy of selective trabeculoplasty, but were not observed in our study due to its lack of statistical power for measures of pre-laser IOP [23-27], age [27], use of a prostaglandin before SLT (which may be a factor for lower efficacy) [26] or treatment energy levels [27,28]. Lee, et al. has also evaluated optimal total treatment energy, at 226.1 mJ [29].

Our study strengthens the interest of the use of this recent treatment in the management of glaucoma patients in an ophthalmology department, as long as the

irido-corneal angle allows sufficient access to the trabeculum, and this regardless of the stage of the pathology.

In conclusion, SLT is a safe and effective technique for reducing IOP. Applicable at any time in the development of the disease, its place in the therapeutic arsenal for treating open-angle glaucoma is justified. Due to the depletion of the hypotonic effect over time, it may be interesting to study the evolution of IOP in the longer term and on a larger number of patients, as well as the efficacy of retreatment.

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