ARGON VERSUS SELECTIVE LASER TRABECULOPLASTY

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SUMMARY

Purpose: To compare conventional argon laser trabeculoplasty (ALT) with selective laser trabeculoplasty (SLT) in terms of their efficiency in lowering the intra-ocular pressure.
Methods: In this retrospective study, 56 eyes from 44 patients with primary open angle glaucoma, ocular hypertension, pseudo-exfoliative (PXF) or pigment dispersion glaucoma (PDG) were included. Patients underwent either ALT (n=18) or SLT (n=38). The intraocular pressure (IOP) was measured immediately prior to and 3 to 5 weeks after the therapy.
Results: At 3 to 5 weeks the IOP-reduction was 22.4% after ALT *and* 15.5% after SLT (p= 0.141). Of note, of the four patients with PDG 2 underwent ALT and 2 SLT. Remarkably, both patients who had had SLT showed a paradoxical rise in IOP after the procedure (+15.5%). When these patients were excluded from the analysis, a similar hypotensive efficacy was found between ALT (-19%) and SLT (-17.9%) (p= 0.836). A small additional study with lower energy levels (< 0.9mJ) confirmed the paradoxical IOP rise in 6 patients with heavily pigmented angles (2 with PDG and 2 with PXF)(+19.2%).
It occurred in the absence of steroid treatment and persisted until 12 weeks after treatment.
Conclusions: The short term efficacy of ALT and SLT was similar. In this study, the patients with PDG who underwent SLT showed a paradoxical rise in IOP. This finding may indicate that even lower energies (0.4 to 0.6mJ) are required when performing SLT in patients with heavily pigmented trabeculae.

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RÉSUMÉ

Le but: Comparer la baisse de la pression intra-oculaire (PIO) obtenue après une trabéculoplastie au laser à Argon (ALT) avec celle obtenue après une trabéculoplastie au laser sélectif (SLT).
Méthodes : Dans cette étude rétrospective, 56 yeux de 44 patients présentant un glaucome à angle ouvert, une hypertension oculaire, un glaucome pseudo-exfoliatif (PXF) ou un glaucome pigmentaire (PDG) ont été inclus. Les patients ont subi une ALT (n=18) ou une SLT (n=38). La pression intra-oculaire (PIO) a été mesurée immédiatement avant et 3 à 5 semaines après le traitement au laser.
Résultats: Trois à cinq semaines après la trabéculoplastie, il y avait une réduction de la PIO plus grande après ALT (22.4%) qu'après SLT (15.5%) (p = 0.141). A noter que, des quatre patients avec un glaucome pigmentaire, 2 avaient subi une ALT et 2 une SLT. Étonnamment, les deux patients qui avaient subi une SLT montraient une élévation paradoxale de la PIO (+15.5%) après 3 à 5 semaines. En excluant de l'analyse ces 4 patients avec un glaucome pigmentaire, l'efficacité des deux lasers était comparable: 19% de réduction tensionelle pour l'ALT et 17.9% de réduction tensionelle pour la SLT (p = 0.836). Une étude additionnelle, en utilisant la SLT avec des énergies plus faibles (< 0.9mJ) chez 6 autres patients avec un trabéculum très pigmenté, a confirmé l'élévation paradoxale de la PIO après laser (+19.2%). Cette élévation de la PIO après le traitement au laser SLT s'est produite en l'absence de traitement par stéroïdes et a persisté jusqu'à 12 semaines après le traitement.
Conclusions: L'efficacité à court terme de l' ALT et de la SLT est comparable si on exclut les patients avec un glaucome pigmentaire. Dans cette étude, les patients avec un glaucome pigmentaire qui avaient subi une SLT, ont montré une élévation paradoxale de la PIO 3 semaines après le traitement. Ceci peut indiquer que des énergies inférieures à 0.6mJ sont nécessaires pour effectuer une SLT chez les patients avec un trabéculum fortement pigmenté.

SAMENVATTING

Doel: Vergelijking van de efficiëntie van oogdrukdaling bij de conventionele argon laser behandeling versus de selectieve laser trabeculoplastie.
Methode: In deze retrospectieve studie werden 56 ogen van 44 patiënten met primair open hoek glaucoom, oculaire hypertensie, pseudo-exfoliatief (PXF) of pigment dispersie glaucoom (PDG) geïncludeerd. De patiënten ondergingen ofwel ALT (n= 18) ofwel SLT (n= 38). De oogdruk werd gemeten onmiddellijk voor en 3 tot 5 weken na de behandeling.
Resultaten: 3 à 5 weken na de behandeling was er meer drukdaling in de ALT groep : 22,4% versus 15,5% in de SLT groep hetgeen nochtans niet significant was (p=0,141). Er waren 4 patiënten geïncludeerd met pigment dispersie glaucoom, waarvan er 2 ALT en 2 SLT ondergingen. Merkwaardig was dat precies de 2 patiënten die met SLT werden behandeld een paradoxale oogdrukstijging (15,5%) ontwikkelden na de behandeling. Bij exclusie van deze patiënten was de efficiëntie van ALT (19%) en van SLT (17,9%) vergelijkbaar (p= 0,846). Een aanvullende kleine studie met lagere energie niveaus (<0,9mJ) bevestigde dit (+19,2%). Deze oogdrukstijging geschiedde los van cortisone gebruik en persisteerde gedurende 12 weken.
Besluit: De korte termijn efficiëntie van ALT en SLT is vergelijkbaar. In deze studie ontwikkelden de patiënten met pigment dispersie glaucoom die werden behandeld met SLT een paradoxale oogdrukstijging. Mogelijks betekent dit gegeven dat een nog lagere energie nodig is (0,4 à 0,6mJ) om patiënten met dense trabeculaire pigmentatie te behandelen.

KEY WORDS

laser therapy, trabeculoplasty, glaucoma, pigmentary, ALT, SLT.

MOTS-CLÉS:

traitement au laser, trabéculoplastie, glaucome, pigmentaire, laser conventionnel à argon, laser à fréquence double sélectif.

INTRODUCTION

Lowering the intraocular pressure (IOP) is still the most efficient way to prevent the development and progression of glaucoma (2,4,12). Medical therapy is most often utilized as initial management strategy to lower the IOP in glaucoma patients. However, laser trabeculoplasty (LTP) may offer a cost-effective alternative or an additional IOP-lowering, particularly in patients with low compliance or intolerance to medical therapy. In contrast to surgical treatment for glaucoma, laser therapy does not carry the risk of sight-threatening complications (3,5,9,14).

Laser trabeculoplasty is a safe procedure. The extent and duration of the IOP lowering effect may vary among individuals but overall ALT reduces the IOP with approximately 20% in up to 85% of the patients for a period lasting up to 5 years (4,11-13,15). In patients with ocular hypertension or early glaucoma, trabeculoplasty can be considered as an alternative primary therapy to medication, as supported by the Glaucoma Laser Trial (GLT) (14,16,17). One study even suggested that eyes initially treated with laser had a lower IOP and a better visual field and optic disk outcome than those treated medically (1). Primary open-angle, pigmentary and pseudo-exfoliative glaucoma give the best responses after laser therapy. In juvenile and secondary glaucomas such as neovascular or inflammatory glaucoma, LTP can result in adverse reactions and is contra-indicated (10). Since the IOP lowering effect of LTP is related to the extent of IOP elevation, this treatment is less effective in patients with normal tension glaucoma (2). Clear media and a good view of the trabecular meshwork (TM) are mandatory.

Selective laser trabeculoplasty (SLT) differs from ALT in its lower energy levels, its larger spot size, its repeatability and its mechanism. It is named selective because of the selective targeting of the pigmented trabecular meshwork cells instead of overlapping both the pigmented and non-pigmented trabecular meshwork. SLT treatment appears to be safe and effective in patients with primary open angle glaucoma (POAG) and patients treated previously with

ALT (8,10). ALT was initially thought to induce thermal alterations of the trabecular meshwork (the mechanical theory); the trabecular beams would adhere to each other, widening the intertrabecular spaces, thereby facilitating outflow but inducing scarring (1,6,11). More recently, it has been suggested that thermal alterations of the trabecular meshwork initiate a biological cascade of events that results in enhanced outflow (the cellular theory) (1,3). SLT is thought to selectively target the pigmented cells with short pulses of low energy, causing a photochemical rather than a coagulative reaction and sparing adjacent cells from collateral thermal damage (1, 3, 6, 10).

Both ALT and SLT stimulate macrophage recruitment and the release of cytokines. These macrophages in turn engulf the debris in the trabecular meshwork, improving the aqueous outflow (1,3). Selective photothermolysis has three requirements: first there must be an intracellular chromophore that is not present in the surrounding cells. Second the target chromophore (i.e., melanin) must have preferential absorption for a given laser wavelength over the background (i.e., the surrounding non-pigmented trabecular tissue). Third, the pulse duration of the radiant energy source should not be longer than the thermal relaxation time of the target chromophore (the absolute time needed by the chromophore to convert electro-magnetic radiant energy into heat energy) (3). Because of its lower energy and far shorter pulse duration (nanoseconds instead of microseconds), SLT doesn't cause collateral damage and is therefore repeatable. This is a benefit over ALT, since, because of the coagulation damage and scarring, the latter laser can only be repeated superiorly which is technically more difficult to perform (1,7,9). Both lasers are polyvalent. ALT can be used for retinal photocoagulation and can be combined with a YAG laser (Combolaser®, Technop, Belgium). The recently commercialised combined doubled frequency SLT/Yag can also be used for Yag iridotomy and capsulotomy (Laserex®, De Ceunynck Medical, Belgium).

The aim of this study was to compare the short term IOP-reduction after argon *versus* selective laser trabeculoplasty in a group of 56 patients with chronic open angle glaucoma.

PATIENTS AND METHODS

Both laser treatments were performed according to a standard protocol and by two clinicians. ALT was performed with an Argon blue-green laser with a wavelength of 488 to 514 nm. Approximately 45 to 55 spots with a diameter of 50μm were applied with one spot size in between the spots. The spots were placed at the junction of the anterior non-pigmented and posterior pigmented trabecular meshwork (TM) along the inferior 180°.

SLT was performed with the Q-switched 532 nm frequency-doubled Nd:YAG laser. About 50 confluent, non-overlapping spots of 400μm were applied along the inferior 220° degrees, covering the entire width of the TM *(Figure 1)*.

The spot duration was 0.1 seconds for ALT and 3 nanoseconds for SLT. The energy level was set on 950 mWatt for ALT and a thousand times lower for SLT (0,8 to 1,2 mJ). The minimum energy to produce micro bubble formation and/or blanching was used (6).

One drop of apraclonidine 5mg/ml (Iopidine® Alcon) and pilocarpine 2% was instilled before laser therapy to avoid post-laser IOP spikes and to widen the angle. After the laser therapy the patients continued their local anti-glaucoma medication and used a topical non-steroidal anti-inflammatory drug or Dexamethason (if they where using a prostaglandin analogue) qd for 2 weeks.

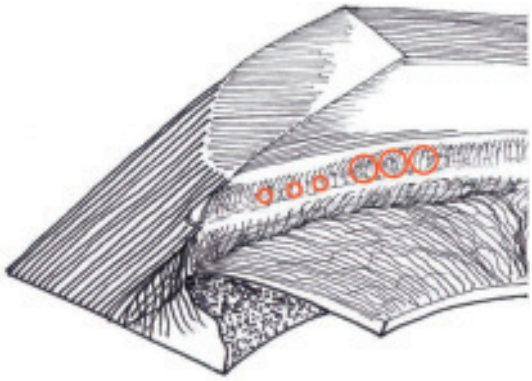

Figure 1: Gonioscopic photograph comparing the spot placements for ALT (left dots) and SLT (right dots) (drawing by T. Missotten)

RESULTS

The baseline characteristics are summarized in the table. These were comparable in the ALT and SLT group, except for the trabecular pigmentation and the number of pre-laser medications. ALT was preferentially performed in patients with a densely pigmented TM, whereas patients with a weakly pigmented TM rather underwent SLT. Four patients in the ALT group and 6 patients in the SLT group were treated in both eyes with the same technique. One person received ALT in the first eye and SLT in the second eye. The number of pre-laser medications was significantly higher in the ALT group: 2.3 *versus* 1.6 (p=0.01).

The number of post-laser medications, on the other hand, was comparable; respectively 1.6 after ALT versus 1.8 after SLT *(Table)*.

The IOP lowering effect 3 to 5 weeks after laser treatment was 22,4% for ALT (range 0 to 37%) and 15,5% for SLT (range 25% IOP-elevation to 37% IOP-lowering) (p= 0.141) *(Figure 2)*. There were no complications noticed after ALT. The mean energy used with SLT was 1.1 mJ.

It was remarkable that of the 4 patients who were included with pigment dispersion glaucoma, those who received SLT showed a paradoxical IOP-elevation of 15.5%, whereas an IOP-reduction of 37% was obtained in those who were treated with ALT. After excluding these 4 eyes the efficacy of the two laser therapies was more similar: an IOP-reduction of 19% after ALT and 17.9% after SLT (p=0.836) *(Figure 3)*.

Table: *Baseline characteristics of the study. IOP lowering % and medications after treatment.*

	ALT (n=18)	SLT (n=38)
TM pigmentation	dens	less dens
Race	caucasian	caucasian
Gender	♂ / ♀= 6/8	♂ / ♀= 12/20
Mean Age (years)	69.7	69.2
IOP pre-laser (mmHg)	21.7	20.9
Nr. Meds pre-laser	2.3	1.6
IOP _ post-laser (%)	22.4	15.5
Nr. Meds post-laser	1.6	1.8

To confirm these observations we treated another 6 patients with heavily pigmented TM (4 eyes with PXF and 2 with PDG) with SLT at lower energy settings of 0.6 to 0.9mJ. Again, an average IOP-elevation of 19.2% was observed in these patients, with 5 out of 6 patients exhibiting a paradoxal IOP-rise.

DISCUSSION

ALT and SLT offer different approaches to a similar treatment. Potential advantages of SLT over ALT are its selective targeting of pigmented trabecular cells, the absence of peripheral anterior synechiae formation or collateral damage, and its repeatability. We know from former studies that argon laser therapy is very efficient in pigmentary and pseudo-exfoliative glaucoma patients (16).

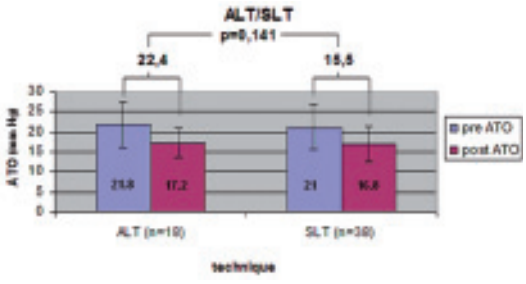

Figure 2: IOP-lowering after ALT *versus* SLT.

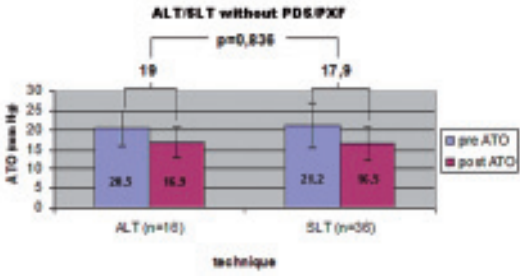

Figure 3: IOP-lowering after ALT *versus* SLT with exclusion of patients with pigmentary and pseudo-exfoliative glaucoma.

The aim of this study was to compare the short term IOP-lowering efficacy of both techniques. Because of the retrospective character of the study, two biases were noted upon the analysis of the data. Since SLT is suggested to be more efficient in weakly pigmented trabeculae, we tended to treat patients with heavy trabecular pigmentation with ALT and patients with a weakly pigmented trabeculum with SLT (9). Moreover, the group that underwent ALT were on average taking more medications before the laser procedure, whereas the number of post-laser medications was comparable in both groups. Therefore, the IOP-lowering effect of ALT may be relatively underestimated as compared to SLT in our study.

Compared with previous studies using similar energy levels, we only found a similar IOP-lowering effect with both techniques when patients with PDG were excluded. Indeed we observed a paradoxical IOP-rise after SLT in the 2 patients with pigment dispersion, whereas the results were excellent after ALT in 2 other patients with pigment dispersion. Former studies have indicated that argon laser trabeculoplasty is very efficient in patients with pigmentary glaucoma (pigment dispersion and pseudo-exfoliation) (16).

This paradoxical IOP rise after SLT in patients with pigment dispersion was also previously shown by Damji et al. (3). A possible explanation could be the increased inflammation observed during the first 24hrs after SLT treatment (compared to ALT) as shown by Cioffi et al (1). Another explanation might be that SLT selectively targets the pigmentary trabecular cells with a larger spot size, and therefore causes a higher amount of pigment dispersion accounting for the paradoxical IOP rise in patients with pigmentary glaucoma. This seems to be a contradictory result since SLT is considered to be a harmless technique. In fact, this leaves less indications open for SLT and still favours ALT as the gold standard. Before drawing any conclusions this result should be confirmed in a prospective study comparing the effect of ALT versus SLT in pigmented TM using low energy levels (<0.6mJ). A shortcoming of the study is that we did not measure the pressure shortly after laser therapy. Therefore, we cannot comment on the amount of inflammation during the first weeks in our patients. However, we agree with the suggestion by Damji et al that lower energies (0.4 to 0.6 mJ) are probably advisable when performing SLT in patients with pigment dispersion (3).

A prospective study with a larger number of patients, longer follow-up, and the use of lower energy in heavily pigmented trabecular meshworks, is mandatory to confirm our findings.

CONCLUSION

The results of this study indicate that, in the short term, ALT and SLT produce a similar reduction in IOP.

Due to its significantly lower energy, exposure time and its selective character, SLT may be a gentler trabeculoplasty method than ALT. However, the higher inflammatory rate post SLT needs to be further explored. Moreover, additional studies are warranted to confirm the observed adverse IOP-elevation after SLT in patients with pigmentary glaucoma. It is advisable to reduce laser energy of SLT in this particular type of glaucoma.

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