

TRABECULOPLASTY WITH THREE DIFFERENT LASERS: ARGON, SLT, TI-Zph. A COMPARATIVE STUDY.

SUMMARY

Purpose: To compare the tissular changes seen in the trabeculoplasty using three different lasers. The aim of this study is to understand lasers tissue interaction and upon results to discuss mechanism of actions.

Materials and Methods: Using as a model the fresh cadaver eye, trabeculoplasty it is performance with three different lasers with three different levels of energy:

	Argon	SLT	Ti- Zph
Wavelength	488nm/514nm	532nm	790nm
Spot Size	100 μ	400 μ	200 μ
Energy/ Power	100/200/400mW	0.5/1.0/1.5mJ	30/50/80mJ
Pulse Duration	100mlseconds	3 nanoseconds	7 microseconds

Results: Three different levels of depth and area were observed. For the Ti-Zph laser the clinical levels of energy demonstrated evidence tissular changes (50mJ or less) on the deep pigmentary population. The Argon laser showed thermal damage and tissular mechanical stress for each level of energy used. With SLT a discrete change on this superficial pigmentary population of the trabecular meshwork were observed. In none of the cases, histological ciliar evidence of change were observed.

Conclusions: The Argon laser induced higher histological changes, as much thermal as structural. The Ti-Za laser showed deep tissular penetration without structural changes. SLT observed superficial changes on the trabecular meshwork.

INTRODUCTION

Trabeculoplasty, as a clinical method for the treatment of the open angle glaucoma, had demonstrated to be the most accessible method from a practical point of view, and with the lowest indices of adverse collateral effects. Thermal trabeculoplasty with Argon has been the guide method during the last decade on the ambulatory treatment of glaucoma. Adverse events like hypertensive episodes post treatments, or the absence of the necessary hipotensor effects, have created the need to essay new wavelength and levels of energy with different laser sources to achieved more satisfactory results. At the present moment two new modalities for trabeculoplasty have been used using new wavelength provided for SLT and Ti-Zph lasers. The clinical study of this tipe of wavelehtth and methods has demonstrated it is effectiveness. In the present study, the different morphological characteristics observed histological are evidenced, and the probable mechanism of action deduced from each of the methods used.

To mimic the real tissular conditions during trabeculoplasty, and offer the same characteristics, the three different methods and levels of energy are used on the same cadaver eye. The "obitus" was inferior to 24 hours to above histological and morphological changes related to tissular death.

MATERIALS AND METHODS

Three fresh cadaver eyes from three different individuals, provided from the New England Eye Bank Boston MA. Those eyes observed normal anatomical features in all tissues. The cornea presented a paquimetri inferior to 600m. The corneal epithelium had no erosion. No structural variations of the iris where observed, although different grades of pigmentation related to normal individual variants were present. The pupil diameter were off 2.5, 2.6, 2.7 mm. A pigmentary tindall lower than $1/(2 \text{ cells}/\text{m}^3)$ on the aqueous humor was observed. The grade of the angle was four in all the eyes and the lens was present. The ages of the "obitus" were off 43, 53 and 68 years old. Two were men and one woman. The optic nerve presented a lent higher than 3mm in each eye and the external surface of this sclera was normal.

To identify the fraction of the eye in which a specific laser were applied, three different types of sutures (6-0 nylon) were placed 2mm away from the limbus on the sclera. To identify the location were a specific spot of energy from the laser were placed on the trabecular meshwork, a 10-0 nylon limbar stitches were placed in a radial

corneoscleral manner. Those stitches were able to be seen from the anterior chamber when trabeculoplasty were performance (Figure...). Figure... Shows the general conditions in witch the eye was prepared to identify every one of the parameters used in the trabeculoplasty.

Because our aim is to show the same tissular conditions for every laser, all lasers and changes in power/ energy were used on the same eye. In that way we were able to compare every laser trabeculoplasty on the same eye conditions. One of the initials postmortem changes on the cadaver eyes is the presence of a increasing pigmentary tindall on the aqueous of the anterior chamber, depending on the relative moment of the postmortem moment of our observation. To reduces variables associated with this situation, and avoid unknown energy absorption on the path of the laser from the laser source to the trabecular meshwork, we prepared the globe exposing the trabecular meshwork to air the following described method: The eyes were divided in three equal section following and imaginary line that goes from the apex of the cornea until the optic nerve. Using a diamond knife we preceeded to cut and divided the eye following this directions (Figure...) to achieved a better exposure of the angle to the laser, the lens was eliminated what made the iris to fall on the ciliary body (Figure...) this tissular section was mounted on adherent support (sponge) to facilitate handling during trabeculoplasty.

To better understand the histological changes associated to every method, the levels of energy/power of every laser were changes from lower to higher on a clock wise fashion, trying to imitate the real conditions during trabeculoplasty. The three different types of trabeculoplasty were performance in every portion of the globe in a time inferior to 2 hours. Ones the trabeculoplasty was finalized, the piece of the eye were immersed in eye solution of glutaraldehyde for fixation and posterior histological study. Every one of this experiment were performance three times on the three different eyes and every one were sent to three different pathologists for process and study.

RESULTS

The 27 histological cuts in the figure... shows the tissular changes in each method and energies/ power used in every one of the eyes. A eosine- hematoxiline tintion were used to study histological morphology of the tissues exposed to the different laser during trabeculoplasty. Every one of the portion of the eye were identified with a number (Figure...), so numbers 1,2 and 3 correspond to argon; 4,5,6 to SLT and 7,8,9 to Ti-Zph. Each one of the locations was a limbar corneoscleral 10-0 nylon stitch were placed was identified with

the letters a, b and c following higher levels of energy used in every laser and following a clock wise fashion (Figure...). Each one of the pathologists was ask to answer the following questions:

1. Tissular changes respect to control tissue (without treatment).
2. Depth of the tissue treated with laser.
3. Maximal amplitude of changed superficial area.
4. Changes in tissular pigmentary population.
5. Tisular structural distortions at the site of the impact and surrounding areas.
6. Thermal damage.

Investigador A: Boston University

Investigador B: Universidad Complutense de Madrid.

Investigador C: Tel-Aviv University.

DISCUSSION

Trabeculoplasty is clinical methods that have been well adopted in ophthalmology because the simple access of the trabecular meshwork using a gonioscope. In this study we have made small changes in the delivery system of the energy from the laser to the trabecular meshwork. In real conditions some absorption of energy will be present when the laser goes through the gonioscope, the cornea and the aqueous in the anterior chamber. We exposed the trabecular meshwork to air to minimize variable factors related to the cadaveric condition of the human Eye Bank eyes. In that way, the beam from the laser will travel all the time through air before reaching the tissue target. That has the advantage of unifying criteria when we compared the effect of the laser on the trabecular meshwork in our three eyes, and the inconvenience of not knowing the real amount of energy absorbed on the real trabeculoplasty that will be obviously smaller.

The trabecular pathway represents 80% of the drainage of the aqueous humor produced by the ciliary body^{Ref}. The other 20% is effected through the uveoscleral pathway. How much the second pathway is modified during trabeculoplasty is unknown. Using a laser spot size between 100 μ and 400 μ exist the possibility of some energy to fall and absorb by the ciliary meshwork, ciliary muscle and related tissue around the trabecular meshwork since the distance between the Schwalbe line and the scleral spur is above 80 μ . Also is possible that part of the energy delivered by the laser is absorbed in form of shock wave by the tissue close to the point of energy absorption. That

situation could create some late biological response that could enhance the uveoscleral pathway. This route loses activity throughout life as much in primates as in humans. It has been shown that before 50% of the length of life on a subject that shows this unconventional pathway, its flow is comparable to this conventional trabecular pathway. If trabeculoplasty affected or not to the uveoscleral route is not determined in our study, but could be a point of discussion that enhancing this route with laser stimulation could be of some interest.

The mechanism of action of argon laser has been classically described as mechanical. The point of maximal absorption of thermal energy changes the tertiary and quaternary space conformation of the collagen molecules (shrinking effect). That originates traction and tissue expansion of the surrounding tissue creating on the trabecular meshwork new flow routes. In this method it appears the contradiction of having to destroy some volume of the trabecular meshwork to open the adjacent one.

The mechanism of action of the laser SLT and Ti-Zph are not based on thermal damage. Probably their mechanism of action consists in a combined action of intracellular and extracellular pigment energy absorption^{Ref} which obviously moves the pool of pigment present in the tissue, and the collateral shock wave created that reaches distance tissue (ciliary body, ciliary muscle, ciliary meshwork) triggering the phagocytes and biological mechanism to enhance uveoscleral pathway.

The Ti-Zph laser has demonstrated deeper penetration on treated tissue so mechanisms of action before described could be specially amplified with this method.

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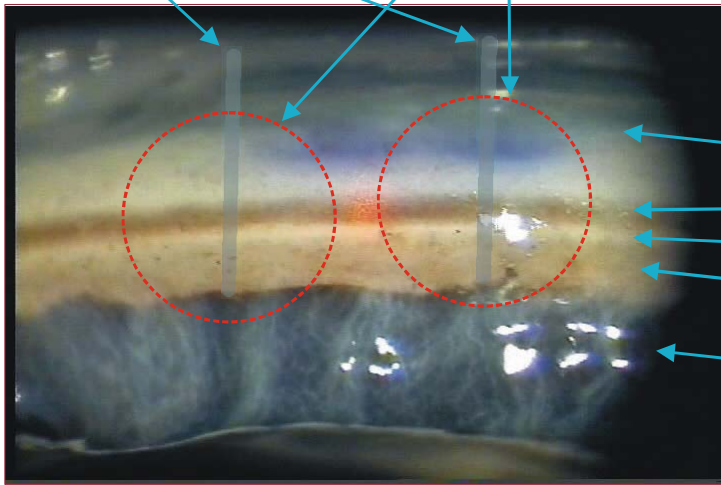
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Nylon 10-0

Localizacion del Spot



Linea de Schwalve

Malla trabecular

Espolon Escleral

Malla ciliar

Iris

