

# Hyperacusis and other Inner Ear Disorders are improving after irradiation with Photobiostimulating Laser.

Joaquín Prósper, AuD<sup>1</sup>; Eugenio Hack, MD, ENT specialist<sup>2</sup>;  
<sup>1</sup>Otoclinica (Madrid, Spain), <sup>2</sup>Department ENT Rotger Clinic (Mallorca, Spain)

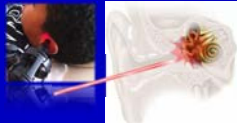
## ABSTRACT

### Purpose:

There are several theories about pathophysiological mechanisms involved in hyperacusis as an inner ear disease. Several authors discuss and focus hyperacusis around neurophysiological processes currently against the cochlear homeostasis disorder. This research describes effects of treatment by laser light irradiation on hyperacusis disease and recognizes that hyperacusis is a cochlear homeostasis dysfunction instead of other auditory or neurophysiological processes.

### Method:

A prospective study of a group of Fifty-eight (58) patients who were suffering hyperacusis from several inner ear diseases (Morbus Ménière, Tinnitus and other disorders) was made with laser irradiation therapy based upon a photobiostimulation energy protocol.



Patients were treated twice a week for six weeks by irradiation of a dose of Low Level Laser Light (LLLT). A laser device with double wavelength and independent light beams were used to irradiate through the ear canal with light power irradiance of 0.2 W/cm<sup>2</sup> to 1.8 W/cm<sup>2</sup>.

### Results:

Hyperacusis was significantly improving in all patients. Among hyperacusis patients 99% of the observations have a large improvement of auditory capacity and 78.9% of them reached normal discomfort levels (no hyperacusis).

### Conclusion:

Irradiation of the cochlea with a specific dose of light laser energy produces an obvious improvement in hyperacusis and other auditory disorders. This can be evaluated by comparing the Audiometric Dynamic Range before and after the treatment period. The results confirm that hyperacusis as a disorder is more susceptible to a cochlear homeostasis abnormal condition than other non well-known neurophysiological processes.

## CONTACT

Joaquín Prósper  
OTOCLINICA (Vestibular & Tinnitus Disorders)  
Email: prosper@otoclinica.es  
Phone: (+34) 915 648 744  
Mobile: (+34) 616 243 654  
Website: www.otoclinica.es

## INTRODUCTION

Several theories about pathophysiological mechanisms involved in hyperacusis as an inner ear disease, have since long been discussed and described in literature.

Authors<sup>1,2</sup> discuss errors in regulating processes of amplification of hearing cells. Other theories about the disorder are based upon central sound processing at a subcortical level. There are also discussions about the role of specific substances that could activate neurotransmitters that could increase both nervous system cell activity and sound perception.

Recently, several studies and research reports on Photobiostimulation and especially Low Level Laser Therapy (LLLT)<sup>3,4</sup> have opened a new window for treatment where cellular metabolism and other molecular mechanisms, involving ATP as a neurotransmitter<sup>5</sup>, provide grounds for a new medical paradigm and new therapies. Up to now, chronic and neuropathic pain have for many years been disorders successfully treated<sup>6</sup> with Laser Therapy.

Regarding chronic hyperacusis, in a study Zazzio<sup>8</sup> reported obvious and undeniable improvements on pain thresholds for all patients who were treated with a multi-therapy protocol which was based upon laser therapy.

## METHOD AND MATERIALS

A retrospective chart review from March 2011 to October 2012 identified patients with a diagnosis of Hyperacusis treated by Laser Therapy.

Our prospective study on 58 patients who were suffering from hyperacusis and several other inner ear disorders such as Morbus Ménière and tinnitus were conducted using laser therapy<sup>3,4</sup>, based upon photobiostimulation effects. Patients (only 1) with some psychopathology condition were discarded.

The UCL (Un-Comfort Levels) were measured for audio-frequencies (pure tones) ranging from 125Hz to 8KHz. The group of 57 patients' ages varied from 18 to 81 years with an average of 47.4 years and a median of 45 years. There were 31males and 26 females.

### Therapy Protocol:

Two types of semiconductor lasers emitting 650nm and 808nm light wavelength (red and infra-red light irradiation) were used.

The standard protocol for all patients was at the beginning of therapy 12 sessions, twice a week.



Irradiation time/dose was adapted to each patient according to individual anatomy, side effects and other detectable reactions. All patients were evaluated two months after the start time of therapy.

### Other Data:

•Laser Power: continuous output was 90mW for 650nm and 300mW for 808nm.

•Irradiation spot area at a distance of 25mm from the laser probe was around 0.20-0.25 cm<sup>2</sup> for the 808nm laser and around 1 cm<sup>2</sup> for the 650nm laser.

•The laser probe tips were placed inside the ear canal at 15-17mm distance from the tympanic membranes.

•The total laser power dose applied each session was adjusted between 54-540 Joules (J) for each laser irradiation. Each patient was dose irradiated according to individual factors and treatment progress.

## DISCUSSION

The objective of our study was to confirm photobiological effects and some molecular mechanisms formulated by Tiina Karu<sup>4,7</sup> and other photobiomodulation researchers<sup>5</sup>. Time ago blood irradiation therapy has been used for many healing process.

Irradiation of blood promotes the improvement of the rheological properties of blood<sup>5</sup> (Mi et al, 2004), increasing the fluidity and activating functions of transport and also activates other indeterminate anti-infections immunity mechanisms, reduce the level of C reactive protein and produce an increase in the content of immunoglobulin's IgA, IgM, IgG in blood serum.

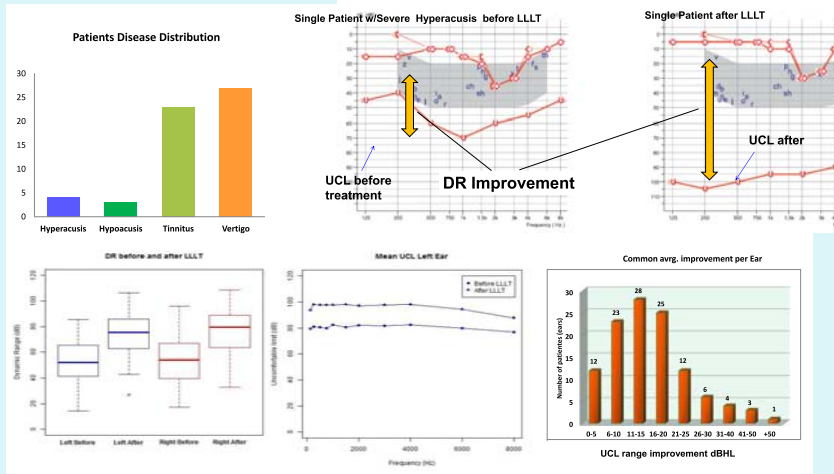
Many of the disorders of the inner ear, sudden hearing loss, dizziness, hyperacusis, etc., are the result of a possible vascular alteration and/ or degradation of endocochlear homeostasis. Multiple proteins and other molecules, connexins, fibrocytes and genes are involved in the vascularization of the "stria vascularis" and spiral ligament and all of them are fundamental in the ion homeostasis by the cochlear fluids and recycling the K<sup>+</sup>.

## RESULTS

Index variables PTA, mean UCL, mean DR and percentage of patients suffering from hyperacusis. All of them showed an improvement on hyperacusis levels after LLLT. The PTA (Pure Tone Average) was in average 5 dB lower after LLLT. Average UCL (Un-Comfort Level) levels were on average 16 dB higher after LLLT. The DR (Dynamic Range) augmented 20 dBHL in average and the POH (Percentage of Observations regarded as Hyperacusis) decreased by 30-50 %.

About these index variables of patients with hyperacusis all showed a difference in levels after LLLT. Our report data<sup>9</sup> shows that all observed changes are statistically significant, implying improvements in certain hearing parameters, noise/tinnitus reduction, fullness inner ear pressure and other vestibular symptoms of patients treated with laser photo-therapy or light irradiation.

## Dynamic Range AUDITORY Index before/after THERAPY



## CONCLUSIONS

The results<sup>9</sup> confirm that hyperacusis as a disorder more susceptible to a dysfunction of cochlear condition than of other known neurophysiological processes. After therapy all patients had an improvement or a total recovery both on their hyperacusis and often also on other inner ear disorders such as tinnitus, Ménière's disease or vertigo.

We confirm most of patients recovery normal levels of noise/sound tolerance or UCL's (Un-Contort Levels) after light irradiation. We are absolutely sure that photo-biological effects and Laser Photo-Therapy (LPT), involved in the cochlear homeostasis, opens a new approach for the management of hyperacusis and other inner ear disorders. Future studies will assess the long-term benefits of LLLT for the treatment of inner ear diseases.

## REFERENCES

- Jastreboff PJ, Jastreboff MM. Tinnitus retraining therapy (TRT) as a method for treatment of tinnitus and hyperacusis patients. J Am Acad Audiol 2000; 11: 162-177.
- Herranz C. et al. Estudio de la Hiperacusis en una Unidad de Acúfenos. Acta Otorrinolaringol Esp 2003; 54: 617-622
- Jan Tunér & Lars Hode. The New Lasertherapy Handbook. Prima Books AB, printed Sweden. 2010. ISBN 13978-91-976478-2-3
- Tiina Karu. Ten Lectures on Basic Science of Laser Phototherapy. Prima Books AB, printed Sweden. 2007. ISBN 978-91-976478-0-9
- Khakh, B.S., and Burnstock, G. (2009). The double life of APT. Sci. Am., 12, 84-92
- Mi XQ, Chen JY, Cen Y, et al. A comparative study of 632.8 and 532 nm laser irradiation on some rheological factors in human blood in vitro. J Photochem Photobiol B. 2004; 74:7-12. [PubMed:15043841]
- T. Karu. Mitochondrial Mechanisms of Photobiomodulation in Context of New Data About Multiple Roles of ATP. Photomedicine and Laser Surgery, Volume 28, Number 2, 2010, 159-160
- Zazzio M. Pain threshold improvement for chronic hyperacusis patients, a prospective clinical study. Photomed Laser Surg. 2010 Jun. 28(3):371-7.
- Graffelman, J., Prósper, J. The Analysis of Audiometric Measurements before and after Low-Level Laser Therapy of Spanish Patients with Hyperacusis. Report from Department of Statistics and Operations Research Universitat Politècnica de Catalunya. April 2013. Av. Diagonal 647, 08028 Barcelona, Spain. Contact email: jan.graffelman@upc.edu