How Low-Level LASER Treatment Affects Audition

New Frontiers in the Clinical Treatment of Hearing

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Humans need light...

- Human cells routinely respond (and even require) to photons in visible light.
  - E.g., vitamin D production
  - Changes in mood and cortical function when light is withheld (Seasonal Affective Disorder)

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How Can Light Influence the Cochlea?

- The mechanism at hand is based on the science of **photochemistry**, which is the excitation of electrons through the absorption of specific photons, allowing electrons to participate more readily in chemical reactions.

- In accordance to the first law of photochemistry, the observable biological effect following low-level laser therapy can only **transpire in the presence of a photoacceptor molecule**, a molecule capable of absorbing the photonic energy emitted. 

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Human cells receive and process light

- A structure in all human cells similar to the chlorophyll in plants exists in cells that absorbs the photos from specific wavelengths of light:
  - cytochromecoxidase.

Cytochrome C Oxidase is the terminal enzyme of the electron transport chain (ETC) in the mitochondria.

The ETC is a key component in the production of ATP.
Human cells receive and process light

- When a light photon is absorbed in the cytochromecoxidase in the mitochondria, this makes more electrons available to the cell.
- For the cell, more available electrons means more energy available, and more chemical and biological reactions.
- This mainly results in more ATP production.
- But it also has been shown to promote gene expression, protein synthesis, cell proliferation & replication, and suppress inflammation.

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The Human Plant

- Plants and humans both possess electron transport chains (ETC) in order to produce ATP.
- Like the plant’s ETC, the purpose of human cell ETC is to produce ATP in order to drive numerous reactions.
- The major difference is plants acquire electrons through the absorption of light and humans acquire electrons via chemical reactions.

![Figure J-13: Electron Transport Chain](image)

The electron transport chain is a series of protein complexes located at the inner membrane of the mitochondria.

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Human cells receive and process light

- ATP is the driving force for a majority of biochemical reactions within human cells.
- The increased ATP production consequently produces reactive oxygen species (ROS).
- ROS = think “positive benefits of antioxidants”
Basic cellular interactions

- Numerous studies have exhibited laser therapy’s ability to induce an assortment of cellular reactions in non-photosynthetic cells by altering cell bioenergetics.
- The modulation of cellular metabolism and signal transduction has been found to alter gene expression, cellular proliferation, intra-cellular pH balance, mitochondrial membrane potential, generation of transient reactive oxygen species and calcium ion level, proton gradient and consumption of oxygen.
What We Know So Far

1. External application of a low-intensity laser can alter cellular function of tissues below the surface.
2. The basic mechanism of laser light is to increase ATP production in the cell.
3. ATP production increases cell activity, repairs cellular damage, and promotes vascular growth.
How This Could Improve Hearing

- It is widely known that sensorineural hearing loss is associated with cellular decline in the inner ear (e.g., decline and death of hair cells and supporting cells in the scala media).

- By promoting the basic cellular processes of protein synthesis, cell proliferation & replication, and suppressing inflammation, auditory function *may* be improved.

- But is it?
What we’ve found thus far...

- Sixty-four ears between the ages of 18 and 90 years with a mean of 79 years were enrolled in a double-blind, randomized, placebo-controlled, multi-site clinical trial.
- Of the 64 participating ears, 32 were randomized to the active treatment group and 32 were randomized to the control group.
- Treatment group participants received two treatments one week apart with a dual diode laser system with an output intensity of 7.5mW.
- Subjects were evaluated using the CID W-22 and Abbreviated Profile Hearing Aid Benefit (APHAB) questionnaire.
The Results

- Of the 32 test group ears, 46.88% (15 ears), exhibited a significant increase in word recognition scores from baseline to study endpoint, while 6.25% (2 ears) of the 32 control group ears revealed an improvement, a significant difference between groups (p<0.0005).

- The change in the unaided portion of the APHAB questionnaire scores at the 4 weeks post evaluation point when compared to baseline values revealed a 4.39% reduction for the ears receiving active treatment compared with the control group ears exhibiting a 1.17% reduction, a difference between the groups of 3.22%.

- At all other evaluation points the test group ears consistently revealed a lower global APHAB scores when compared with the control group ears.

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Why This is Important

- These data suggest that low-level laser therapy can serve as a viable therapeutic alternative for the treatment of sensorineural hearing loss, serving as an independent or adjunctive therapy to hearing aids and aural rehabilitation therapy.


References (cont’d)


