Traumatic brain injury and concussions:
laser therapy treatment guidelines

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University of Bridgeport
MCM XXVII

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Nelson Marquina, MSc, PhD, DC

- Chief Technology Officer - Laser Biotech International
- Former senior scientist at NASA/Johnson Space Center
- Former manager, Artificial Intelligence Lab at GE
- Former professor of engineering and biophysics at the University of Houston, University of Minnesota, University of Rhode Island, and Virginia State University
- Former director of research at Logan University
- Training doctors in the USA, Japan, China, Argentina…
- MSc in biomathematics and statistics
- PhD in electrical and systems engineering
- Doctor of chiropractic; certified in acupuncture

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Seminar objectives

- Review the concussion and TBI pathophysiology
- Explain the biophysics of laser light effects on neuroinflammation
- Present an integrative model of chiropractic and laser therapy for neuroinflammation
- Review the laser technologies suitable for brain tissue repair and functional improvement
- Learn photonic treatment guidelines for neuroinflammation

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Seminar: Virtual Neurology Summit

August 8 - 11, 2024

https://americanpostureinstitute.com/

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Webinar: craniocervical junction & TMD

The Craniocervical Junction & TMJ Pain: Treatment Strategies

Tuesday, August 20, 2024, 7:00 - 8:00 PM EDT, 1 CEU

UNIFIED VCA VIRGINIA CHIROPRACTIC ASSOCIATION

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Neuropathology of joint and spine pain

September 19 - 22, 2024

https://wichiro.org/

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Automobile collision (24/02/2008)

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Hospital evaluation on 24/02/2008

- Inferior orbit fracture
- Hematoma
- Unable to move left side of face

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Patient 4 days later (28/02/2008)

- Patient felt he is getting worse
- Unable to move eyes laterally

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Patient day after first laser treatment
06/03/2008

Patient received first superpulsed laser treatment 9 days after the accident

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Five laser treatments in 15 days

5 laser treatments

Dr. Mathesie, DC
Lumix 2 - 250W

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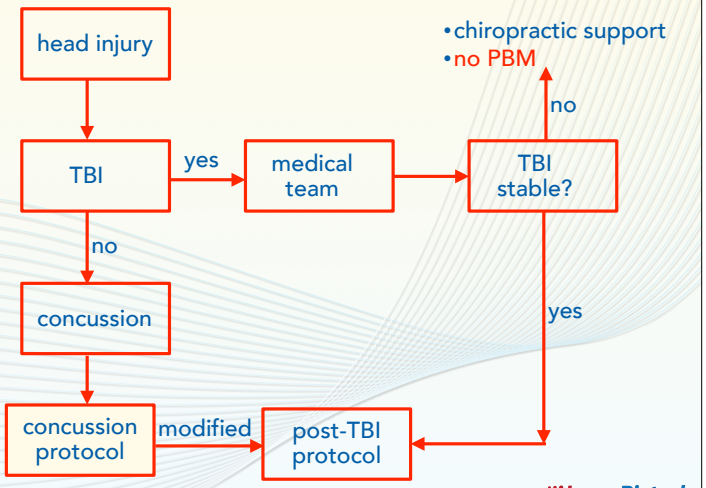
The TBI/concussion landscape



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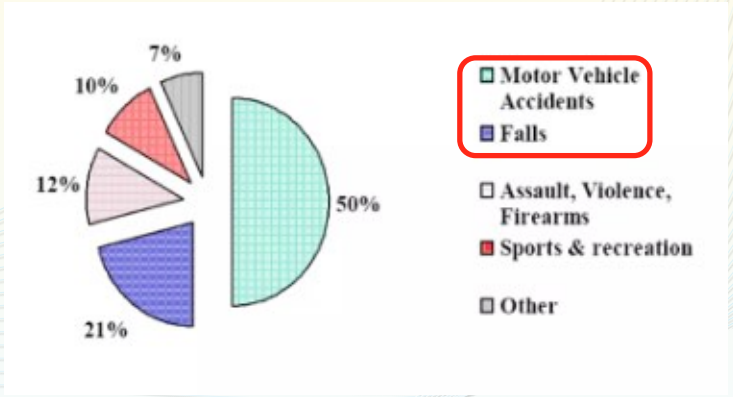
TBI statistics



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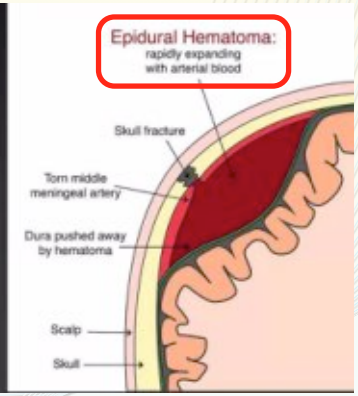
TBI: the presence of blood pool

Accumulation of blood between the dura matter & the skull

Due to damaged middle cerebral blood vessels, frequently by automatic accident



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TBI common findings

- Medical: physical stamina, pain, headaches, seizures, bowel/bladder continence
- Motor: paresis or spasticity, gross motor strength, fine-motor speed and dexterity, motor coordination and planning, spatial-based movement, oculomotor, balance
- Sensory-perceptual abilities
- Attention
- Receptive and expressive language

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TBI: initial assessments

- Glasgow Coma Scale (GCS)
- Galveston Orientation and Ammesia Test

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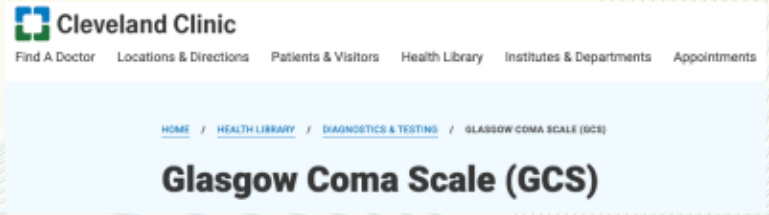
TBI: initial assessments



https://my.clevelandclinic.org/health/diagnostics/24848-glasgow-coma-scale-gcs

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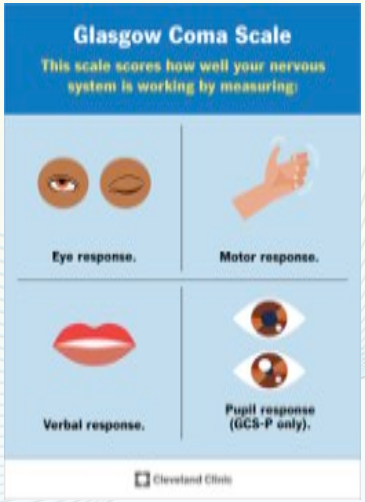
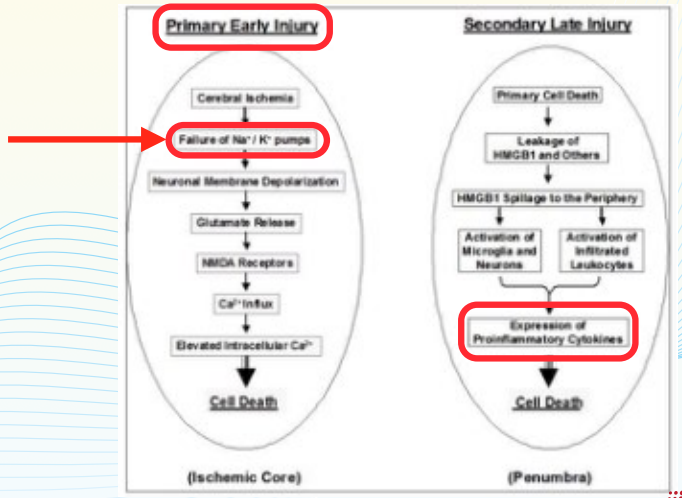
The Glasgow Coma Scale

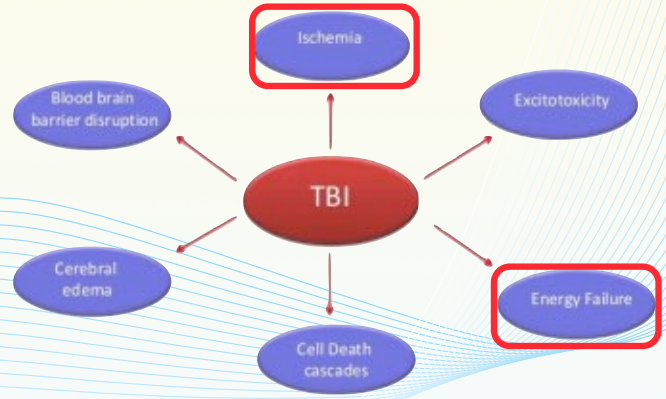
The Glasgow Coma Scale



Post TBI



TBI: where we can have an impact



TBI: chiropractic interventions

- Secondary impairment risks
- Joint integrity and mobility
- Motor function (control and learning)
- Postural control and balance
- Gait and locomotion
- Vestibular assessment and function
- Pain management: chronic and neuropathic
- Repair cellular energy failure: nutrition, laser

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What is a concussion: CDC

A concussion is a type of traumatic brain injury—or TBI—caused by a bump, blow, or jolt to the head or by a hit to the body that causes the head and brain to move rapidly back and forth. This sudden movement can cause the brain to bounce around or twist in the skull, creating chemical changes in the brain and sometimes stretching and damaging brain cells.

https://www.cdc.gov/headsup/basics/concussion_whatis.html

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Concussion: no structural damage

- Loss of consciousness is not necessary
- No detectable brain injury in the acute phase

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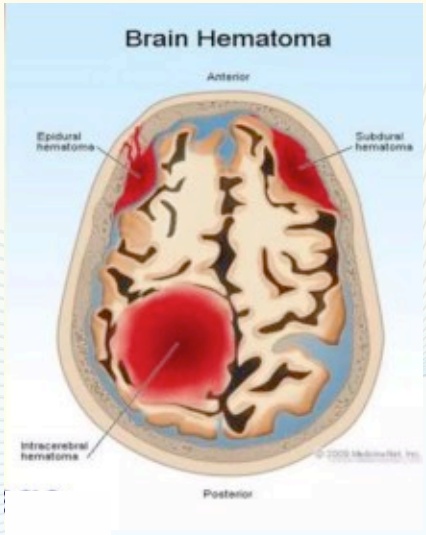
TBI vs. concussion: blood pool



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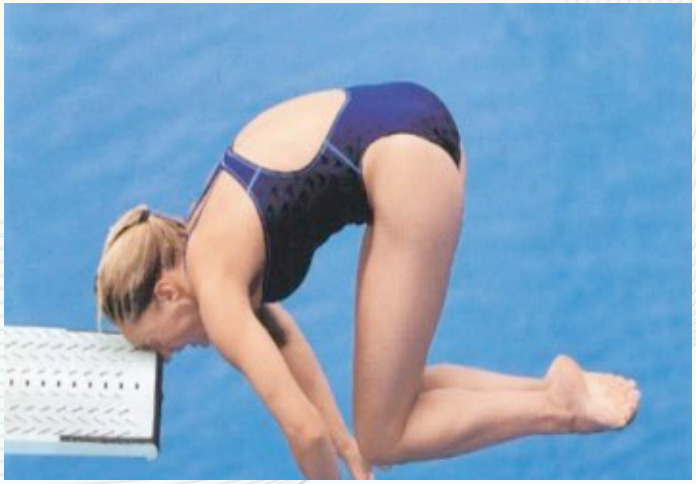
Concussions are common



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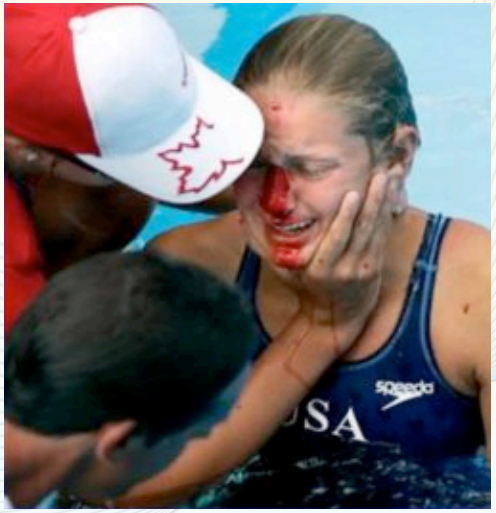
Concussions are common



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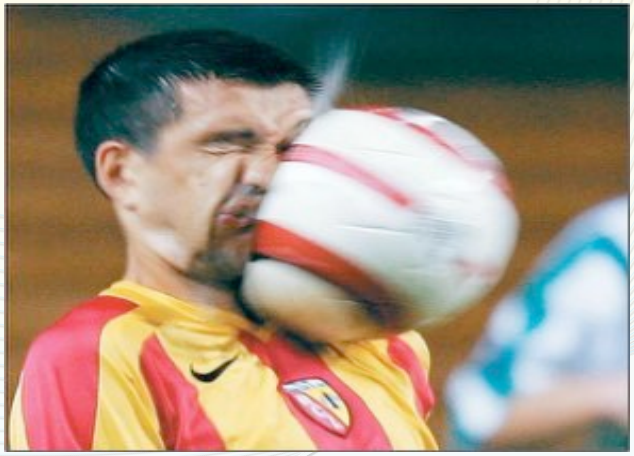
Concussions are common



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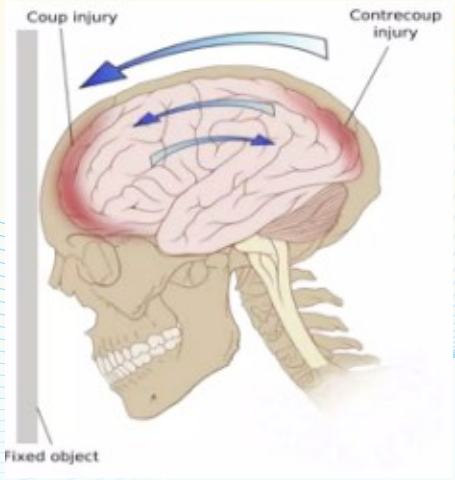
Common concussion type



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Subtle and not so subtle symptoms

Typical symptoms (delayed hours or days):

- Headaches
- Fatigue
- Light/sound hypersensitivity
- Dizziness or vertigo
- Nausea or vomiting
- Mental "fogginess"
- Irritability
- Depression

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Biomechanics of concussion

Clin Sports Med. Author manuscript; available in PMC 2014 Apr 8.
Published in final edited form as:
Clin Sports Med. 2011 Jan; 30(1): 19–vii.
doi: 10.1016/j.csm.2010.08.009
PMCID: PMC3979340
NIHMSID: NIHMS304494
PMID: 21074079

Biomechanics of Concussion

David F. Meaney, PhD[a,*] and Douglas H. Smith, MD[b]

- The brain is subject to translational and rotational forces
- Translational acceleration causes pressure
- Rotational acceleration causes shear
- Rotational acceleration is worse than translational

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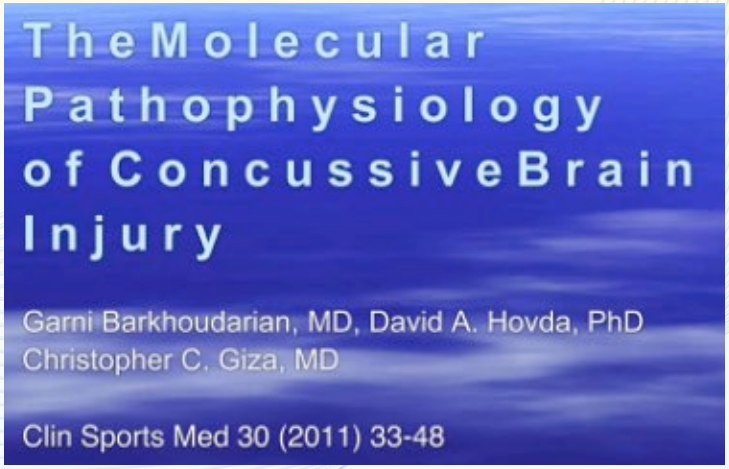
Concussion pathophysiology research



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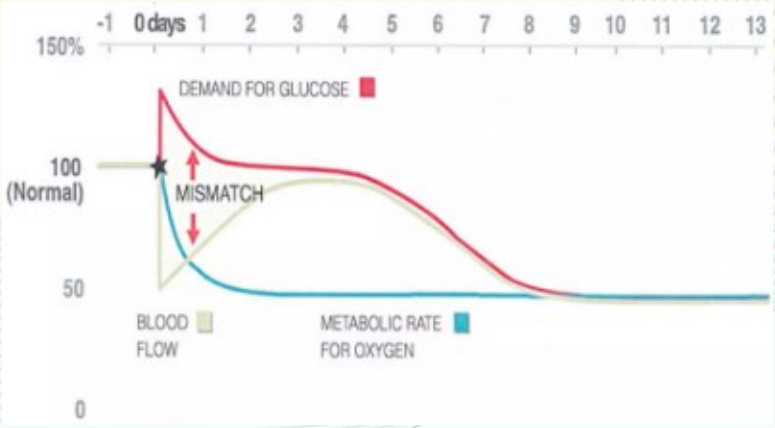
Concussion pathophysiology



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Multiple concussions: high risk flag

- Second Impact Syndrome
  - Further impact before resolution may be catastrophic
  - Diffuse cerebral edema
  - Does it exist?
- Multiple Concussions
  - Subsequent concussions with less provocation
  - Prolonged recovery
  - PCS

Medicolegal exposure!

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High risk of dementia!
JAMA Neurology - September 2018

Original Investigation

September 2018

Association of Mild Traumatic Brain Injury With and Without Loss of Consciousness With Dementia in US Military Veterans

Deborah E. Barnes, PhD, MPH[1,2,3]; Amy L. Byers, PhD, MPH[1,2,3]; Raquel C. Gardner, MD[1,4]; et al

> Author Affiliations

JAMA Neurol. 2018;75(9):1055-1061. doi:10.1001/jamaneurol.2018.0815

Mild TBI means brain imaging without signs of tissue injury

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TBI leads to higher dementia risk

- Data on 350,000 veterans with and without TBI from 2001 to 2013
- Veterans with mild TBI and without LOC experienced twice rate of dementia (4,698 cases)
- Moderate to severe TBI experienced fourfold higher rate of dementia (10,835 cases)
- Those with multiple episodes experienced a ten-fold rate of dementia

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Medical therapies for concussion

Published in final edited form as:
Clin Sports Med. 2011 January ; 30(1): 115–ix. doi:10.1016/j.csm.2010.08.003.

Medical Therapies for Concussion

William P. Meehan III, MD[a,b,*]
[a]Sports Concussion Clinic, Division of Sports Medicine, Department of Orthopedics, Children's Hospital Boston, 319 Longwood Avenue, Boston, MA 02115, USA

- No effective pharmacologic treatment has been shown to speed recovery from concussion or TBI
- As a result, no standard approach exists
- However, medications are used in treating the signs and symptoms of concussion

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Concussion evaluation: history

Symptom history:

- Onset and duration
- Quality and intensity
- Some predictive value:
  - dizziness
  - headache
  - mental fogginess

Concussion evaluation: physical

Physical exam:

- Nystagmus
- Saccades
- Gaze stability
- Balance testing

Concussion evaluation: neurological

Neurocognitive testing - adjunctive tools:

- ImPACT
  - www.impacttest.com
- Headminder
  - www.headminder.com
- Concussion vital signs
  - www.concussionvitalsigns.com

Neurocognitive testing: why do it

- Baseline testing
- High-risk patients, e.g., athletes
- Patients who deny symptoms
- Medicolegal support

Seminar objectives

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Concussion causes neuroinflammation

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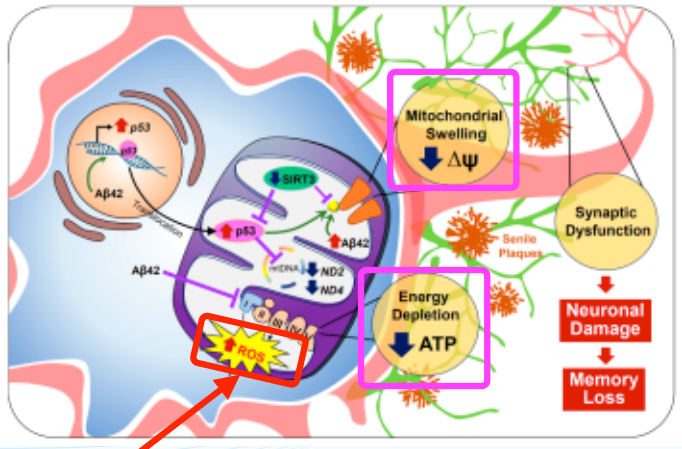
Inflammation damages mitochondria



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And vice versa!

nature > acta pharmacologica sinica > review articles > article

Review Article | Open access | Published: 01 March 2022

Mitochondrial-derived damage-associated molecular patterns amplify neuroinflammation in neurodegenerative diseases

Miao-miao Lin, Na Liu, Zheng-hong Qin & Yan Wang

Acta Pharmacologica Sinica **43**, 2439–2447 (2022) | Cite this article

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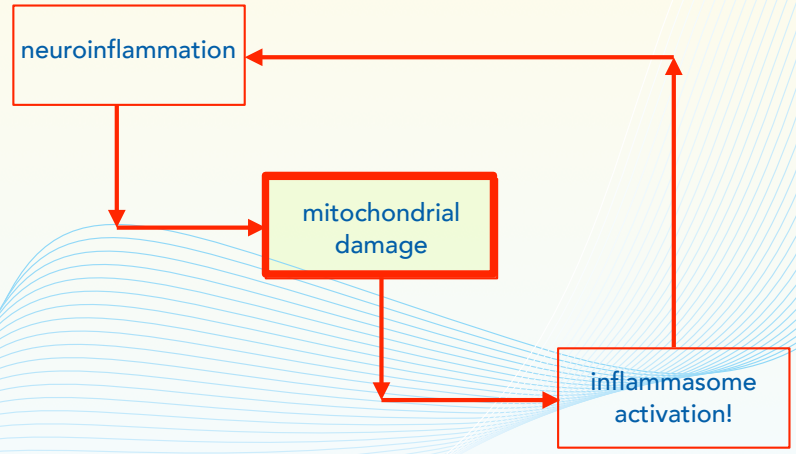
Damaged mitochondria ↔ inflammation



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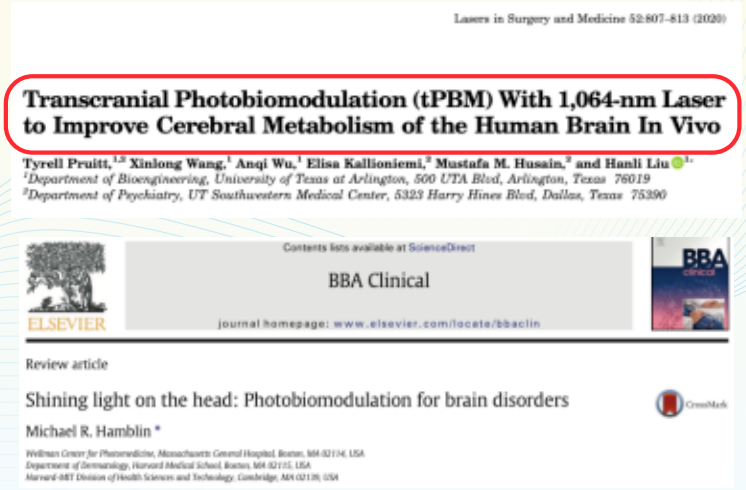
Laser improves brain function



Lasers in Surgery and Medicine 52:807–813 (2020)

Transcranial Photobiomodulation (tPBM) With 1,064-nm Laser to Improve Cerebral Metabolism of the Human Brain In Vivo

Tyrell Pruitt,[1,2] Xinlong Wang,[1] Anqi Wu,[1] Elisa Kallioniemi,[2] Mustafa M. Husain,[2] and Hanli Liu[1]*

[1]Department of Bioengineering, University of Texas at Arlington, 500 UTA Blvd, Arlington, Texas 76019
[2]Department of Psychiatry, UT Southwestern Medical Center, 5323 Harry Hines Blvd, Dallas, Texas 75390

Contents lists available at ScienceDirect

BBA Clinical

journal homepage: www.elsevier.com/locate/bbaclin

Review article

Shining light on the head: Photobiomodulation for brain disorders

Michael R. Hamblin *

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Key finding: balance ATP and ROS

Problem: Generation of ROS during early reperfusion precipitates significant neuronal injury and cell death.

Barriers to Previous Therapeutic Approaches:

- ROS act rapidly (nano to milliseconds) and irreversibly.
- Scavenging compounds must be at the appropriate subcellular targets at the necessary concentration at the time of reflow.
- Pretreatment needed to deliver compounds to ischemic tissue.

Solution: *Non-Invasive Mitochondrial Modulation.*

Hypothesis: Non-Invasive mitochondrial modulation therapy can overcome these barriers to ROS therapy and reduce post-ischemic brain injury.

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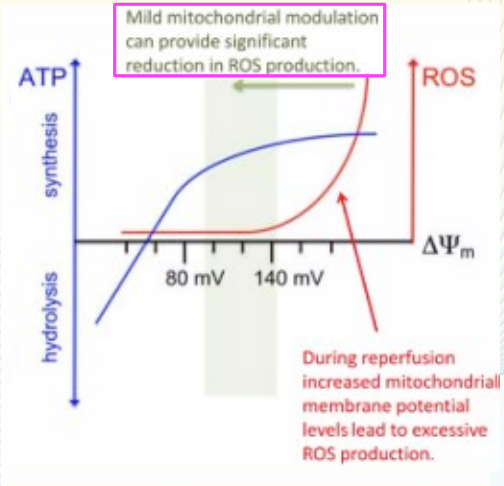
The balance between ATP and ROS



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Human Device Prototyping

The Mitovation Device:

- *Disposable human interface* - Fiber optic light delivery system.
- *Therapeutic light generator* - Compact, portable, and powered by a battery or electrical outlet.

EMERGENCY MEDICINE Mitovation, Inc. MICHIGAN MEDICINE UNIVERSITY OF MICHIGAN

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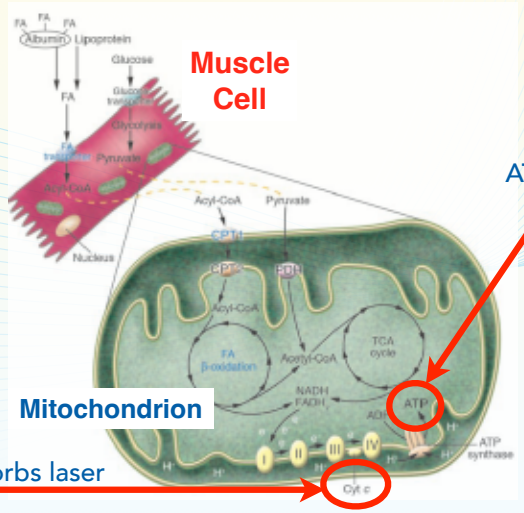
Laser therapy promotes ATP synthesis



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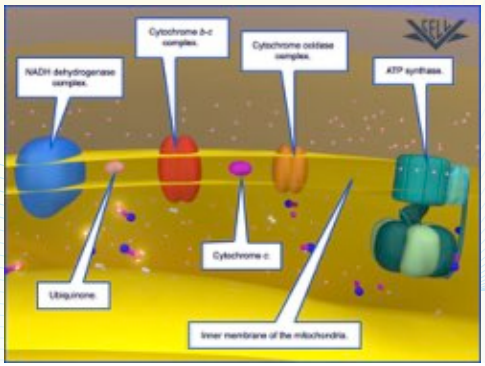
The electron transport chain



The Journal of Physical Chemistry Letters > Vol 13/Issue 50 > Article

Open Access

PHYSICAL INSIGHTS INTO QUANTUM PHENOMENA AND FUNCTION | December 14, 2022

New Perspective on Electron Transfer through Molecules

Ron Naaman*, David H. Waldeck, and Jonas Fransson

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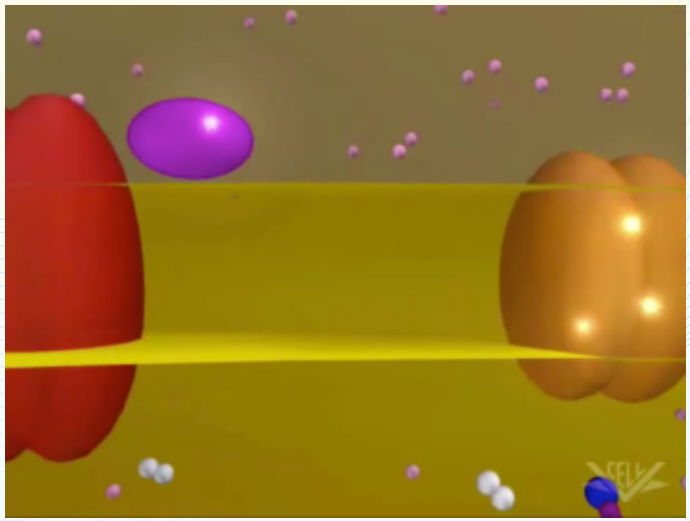
Cytochrome C promotes ATP production



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Mitochondria functions

- ATP Synthesis (aerobic)
- ATP Consumption (anaerobic or aerobic with uncoupling)
- Redox Poise Homeostasis
- Platelet Aggregation and Activation
- Neutrophil Chemotaxis
- Late Neutrophil Oxidative Burst
- Macrophage Activation
- T-Cell Activation
- Sperm cell motility/fertilization
- Angiogenesis
- Lymphedema
- Nitric Oxide Synthesis
- Apoptosis/Caspase Activation
- Prostaglandin Inactivation
- Cholesterol Synthesis
- Cortisol Synthesis
- Mineralocorticoid Synthesis
- Sex Steroid Synthesis
- Vitamin D Metabolism
- Cytoskeleton Architecture/ Mechanotransduction
- Calcium Storage and Release
- Iron Storage and Metabolism
- DNA and RNA--De Novo Pyrimidine Synthesis (DHO-QO)
- Lipids--Fatty Acid Oxidation
- Proteins--Amino Acid Metabolism
- Sugars--Carbohydrate Metabolism (Krebs Cycle)
- Urea Cycle and NH_3 Metabolism
- Peripheral Benzodiazapine Receptor

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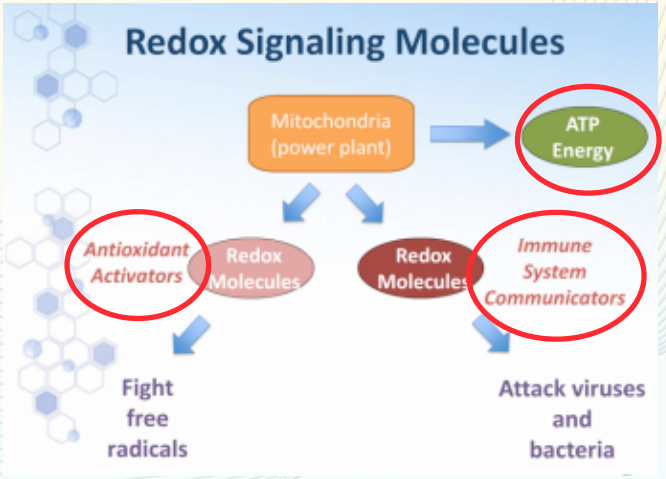
Mitochondria functions



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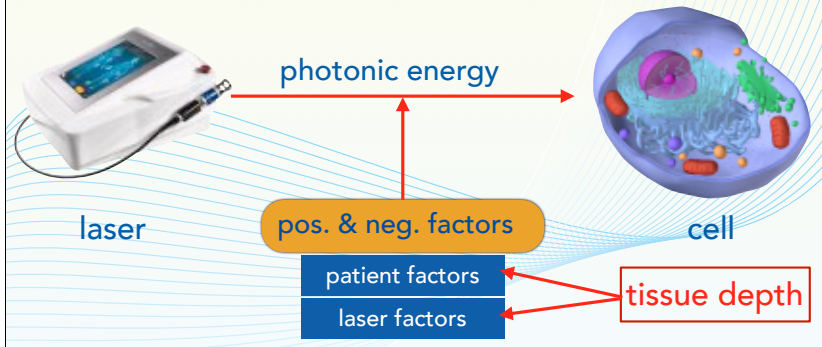
Main purpose of laser therapy?

recharge the mitochondria! that's it!

laser must penetrate and reach target tissues in the correct absorbable energy density!



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The laser therapy foundation

Reach the target tissue with the correct dose of absorbable laser energy

The 3 key factors in laser therapy:

1. Key: tissue penetration
2. Key: correct laser dose at the target
3. Key: target tissue absorption

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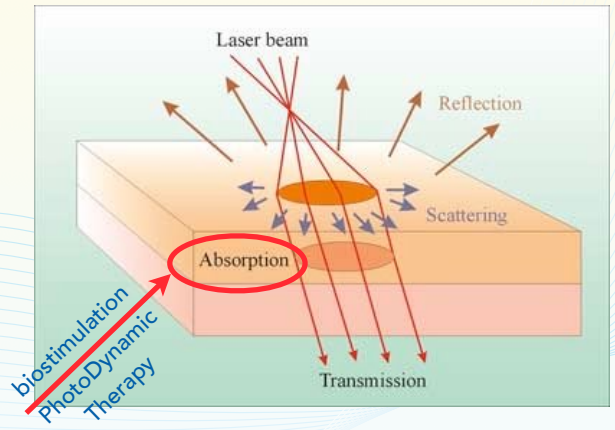
Must have tissue penetration & absorption



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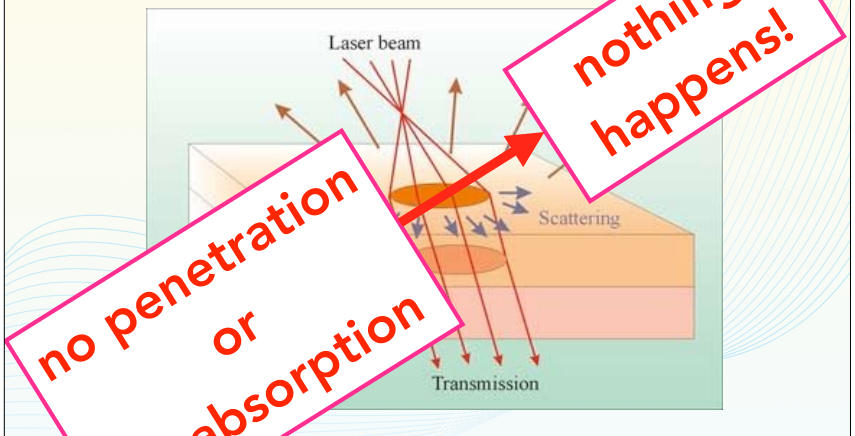
Must have tissue penetration & absorption



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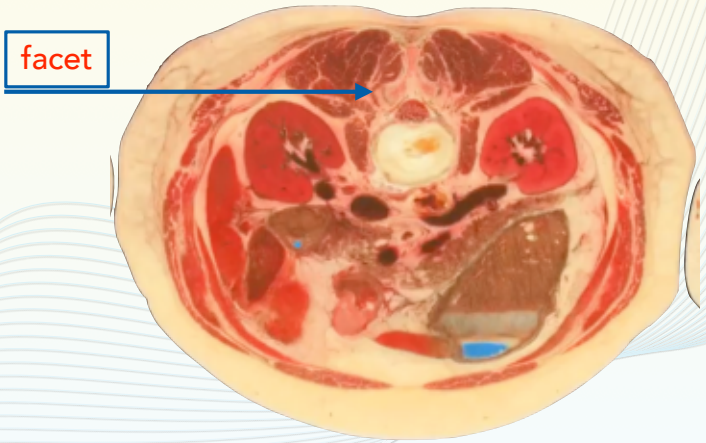
Laser must reach the target tissues



NIH: The Visible Human Project

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Laser therapy: factors to consider

- Laser therapy has many significant factors
- No single treatment protocol could capture all factors

Laser factors:
- Wavelength(s)
- Average power
- Pulse or peak power
- Pulse repetition rate
- Spot size
- Skin contact or not

Patient factors:
- Target tissue depth
- Skin and hair color
- Type of target tissue
- Tissue layers in transit
- Pain source(s)
- Sensitized pain or no

Tissue penetration is a factor of both laser and patient

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On laser dose and tissue penetration

Photobiomodulation, Photomedicine, and Laser Surgery
Volume XX, Number XX, 2020
Mary Ann Liebert, Inc.
Pp. 1–2
DOI: 10.1089/photob.2020.4843

30 June 2020

Light Dosing and Tissue Penetration: It Is Complicated

Raymond Lanzafame, MD, MBA, FACS

Dr. Lanzafame - Director
World Association for Laser Therapy

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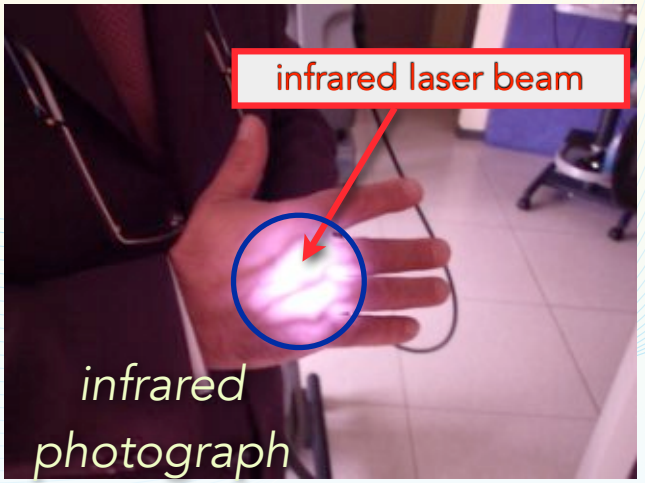
Tissue penetration without damage



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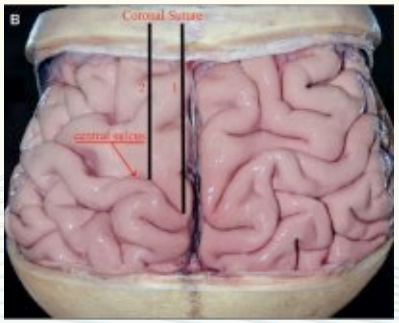
Penetrate brain tissues without damage



25mm transverse section (thick) of human brain

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World Association for Laser Therapy

www.WALTPBM.org

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WALT on tissue penetration

The five factors affecting the laser depth of tissue penetration:

1. The laser's wavelength
2. Whether the laser is CW or superpulsed
3. The average power output
4. The treatment technique used
5. The technical design of the apparatus

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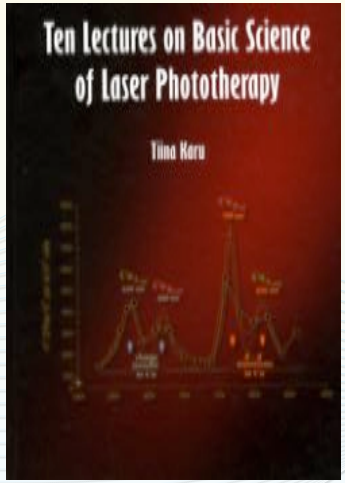
Dr. Karu discovered the role of Cyt C



NM and Tiina Karu, PhD

Dr. Karu discovered the role of cytochrome c in laser therapy

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Dr. Karu on CW & superpulse lasers

- Cellular response to CW, CW pulsed and superpulse lasers differ
- Dose needed for cellular biostimulation were orders of magnitude more for CW lasers as compared to doses of superpulse
- WALT stated a 4-to-1 ratio (clinical basis)

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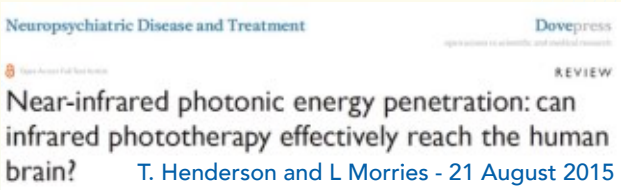
Brain tissue penetration research


Neuropsychiatric Disease and Treatment Dovepress

REVIEW

Near-infrared photonic energy penetration: can infrared phototherapy effectively reach the human brain?

T. Henderson and L Morries - 21 August 2015

- 810 nm delivered 2.9% of the surface power density
- 980 nm delivered 1.2% of the surface power density
- Higher pulse power would penetrate deeper and higher average power would increase heat

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Laser energy loss through the skin

Energy loss due to the skin barrier for
red laser (632 nm) is 90%
and for
superpulse (904 nm) laser is 50%

"A systematic review of low level laser therapy with location-specific doses for pain from joint disorders"

Bjordal JM, et al (2003), Australian Journal of Physiotherapy 49:107-116

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We lose lots of laser light at the skin!

especially on dark skin!

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Bottom line: reach your target

If you can't reach it,
you can't treat it!

- Correct amount is driven by average power
- Tissue penetration is driven by pulse power and wavelength

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On tissue penetration and heat buildup

- power (watts) = quantity of photons
- energy (joules) = power X treatment time (s)

Example:

power = 5 W

treatment time = 10 seconds

energy = 50 joules

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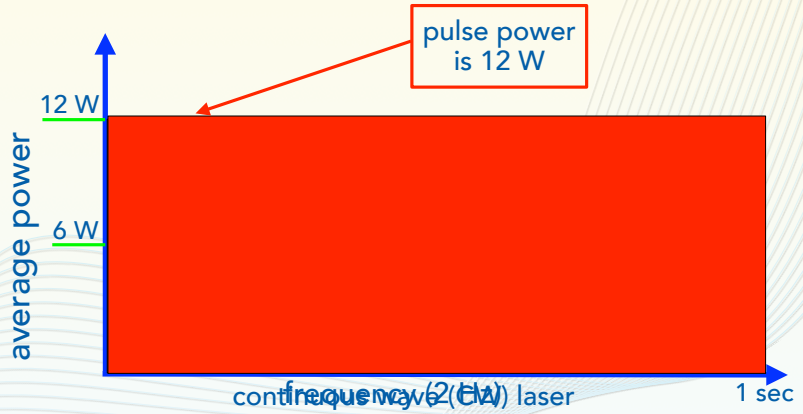
Average and pulse power



NOTE: pulse power = 12 W; average power = 6 W

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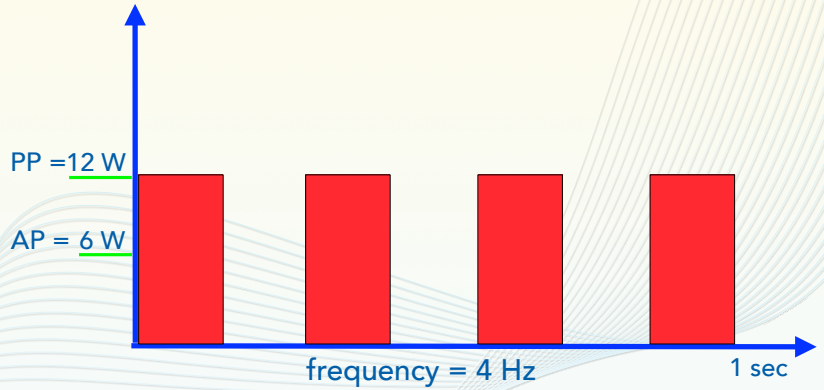
How to increase pulse power



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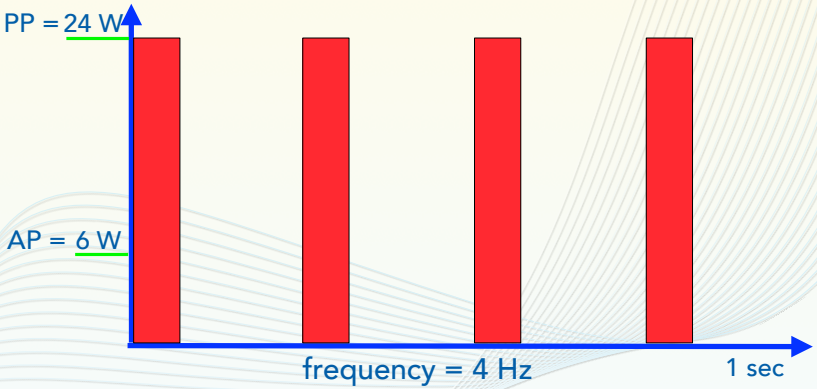
How to increase pulse power



AP = pulse power X pulse duration X frequency

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The most important slide!

AP = pulse power X pulse duration X frequency

5W = 10 watts x 0.5 second x 1 pulse per sec

5W = 10 W x 0.5 s x 1 Hz

5W = 100 W x (0.5 s)/10 x 1 Hz

5W = 10,000 W x (0.5 s)/1,000 x 1 Hz

5W = 10 kW x 0.0005 s x 1 Hz

5W = 10 kW x 0.0000005 s x 1,000 Hz

5W = 100 kW x 0.000000005 s x 10 kHz

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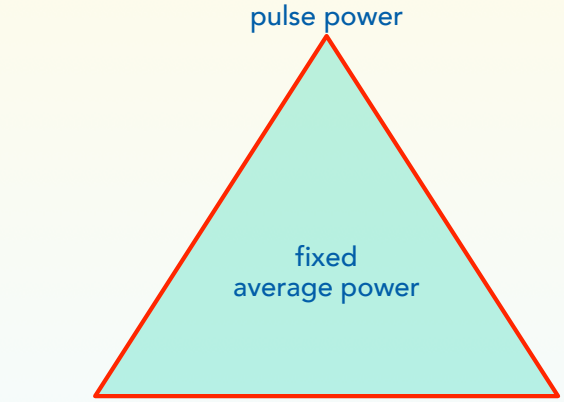
Factors affecting the average power



no free lunch!

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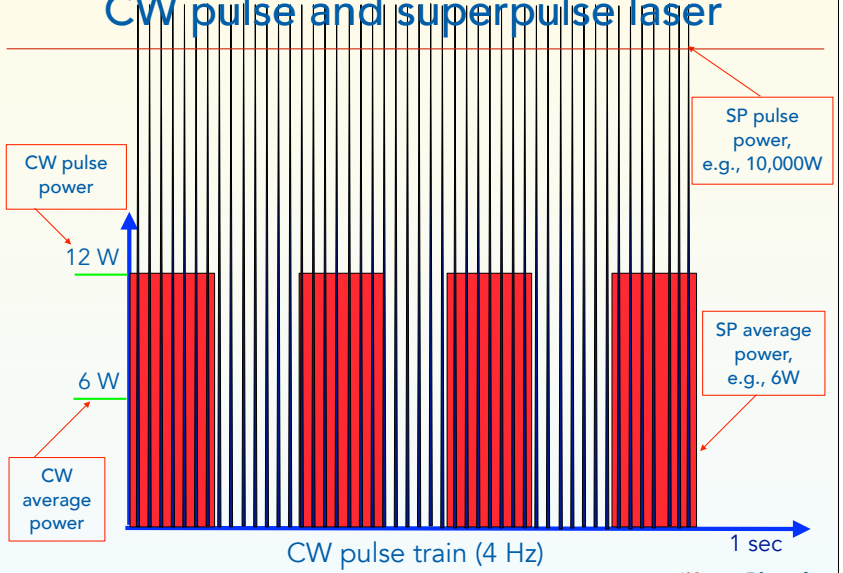
CW pulse and superpulse laser



CW pulse train (4 Hz)

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WALT recommended laser doses

continuous wave lasers

WALT

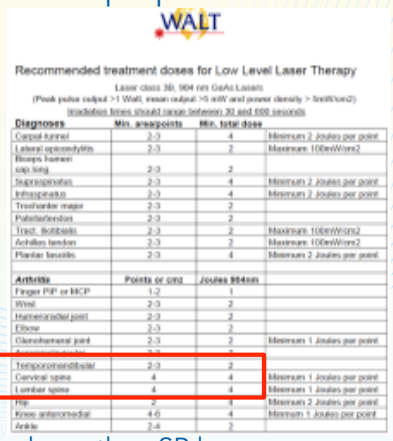
Recommended treatment doses for Low Level Laser Therapy

Diagnoses

Tendinopathies	Points or cm2	Joules 780 - 820nm	Notes
Carpal tunnel	2-3	6	Minimum 4 Joules per point
Lateral epicondylitis	1-2	4	Maximum 100mW/cm2
Biceps tendon c.l.	1-2	6	
Supraspinatus	2-3	6	Minimum 4 Joules per point
Infraspinatus	2-3	6	Minimum 4 Joules per point
Tricep tendon major	2-4	8	
Patellar tendon	2-3	6	
Tract. Iliotibialis	1-2	4	Maximum 100mW/cm2
Achilles tendon	2-3	6	Maximum 100mW/cm2
Plantar fasciitis	2-3	6	Minimum 4 Joules per point

Arthritis	Points or cm2	Joules
Finger PIP or MCP	1-2	4
Wrist	2-4	6
Humeroradial joint	1-2	4
Elbow	2-4	6
Glenohumeral joint	2-4	6
Temporomandibular	1-2	4
Cervical spine	4-12	16
Lumbar spine	4-8	16
Hip	2-4	12
Knee medial	3-6	12
Ankle	2-4	6

superpulse lasers



WALT

Recommended treatment doses for Low Level Laser Therapy

Diagnoses

Diagnoses	Min. areas/points	Min. total dose	
Carpal tunnel	2-3	4	Minimum 2 Joules per point
Lateral epicondylitis	2-3	2	Maximum 100mW/cm2
Biceps tendon sup long	2-3	2	
Supraspinatus	2-3	4	Minimum 2 Joules per point
Infraspinatus	2-3	4	Minimum 2 Joules per point
Tricep tendon major	2-3	2	
Patellar tendon	2-3	2	
Tract. Iliotibialis	2-3	2	Maximum 100mW/cm2
Achilles tendon	2-3	2	Maximum 100mW/cm2
Plantar fasciitis	2-3	4	Minimum 2 Joules per point

Arthritis	Points or cm2	Joules 904nm	
Finger PIP or MCP	1-2	1	
Wrist	2-3	2	
Humeroradial joint	2-3	2	
Elbow	2-3	2	
Glenohumeral joint	2-3	2	Minimum 1 Joules per point
Temporomandibular	2-3	2	
Cervical spine	4	4	Minimum 1 Joules per point
Lumbar spine	4	4	Minimum 1 Joules per point
Hip	2	4	Minimum 2 Joules per point
Knee anteromedial	4-6	4	Minimum 1 Joules per point
Ankle	2-4	2	

CW lasers require higher doses than SP lasers
Typically, a 4-to-1 ratio

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Understanding lasers via animations

Dr. Jeff Aberle, BSc, DC

Continuos Wave - https://www.youtube.com/watch?v=lldDNuI2MaA

Superpulse - https://www.youtube.com/watch?v=_rnoXSV2Ic4

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Pulse rates over 30 kHz promote gene expression and tissue repair

2009

Photomedicine and Laser Surgery
Volume 00, Number 00, 2009

Pp. 1–6
DOI: 10.1089/pho.2009.2501

Original Article

Effect of Low-Level Laser Irradiation on Bisphosphonate-Induced Osteonecrosis of the Jaws: Preliminary Results of a Prospective Study

Matteo Scoletta, D.D.S.,[1] Paolo G. Arduino, D.D.S., M.Sc.,[2] Lucia Reggio, D.D.S.,[1] Paola Dalmasso, M.Sc.,[3] and Marco Mozzati, M.D., D.D.S.[1]

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Laser at >30 kHz promotes gene expression and tissue repair

2017

Lasers in Medical Science
https://doi.org/10.1007/s10103-017-2426-0

ORIGINAL ARTICLE

CrossMark

Effects of high-frequency near-infrared diode laser irradiation on the proliferation and migration of mouse calvarial osteoblasts

Ryo Kunimatsu[1] · Hidemi Gunji[1] · Yuji Tsuka[1] · Yuki Yoshimi[1] · Tetsuya Awada[1] · Keisuke Sumi[1] · Kengo Nakajima[1] · Aya Kimura[1] · Tomoka Hiraki[1] · Takaharu Abe[1] · Hirose Naoto[1] · Makoto Yanoshita[1] · Kotaro Tanimoto[1]

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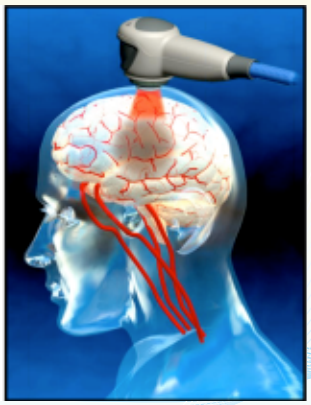
CNS repair research in the armed forces



Juanita Anders, PhD
Uniformed Services University of the Health Sciences

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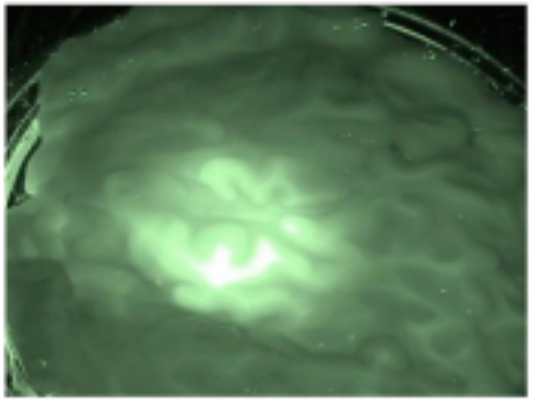
Human brain sulci act as waveguides



Juanita Anders, PhD
Uniformed Services University of the Health Sciences

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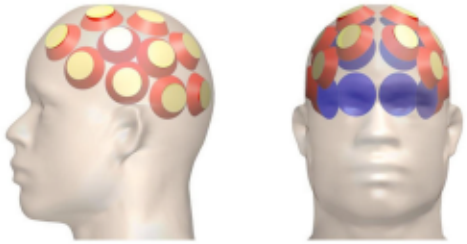
Juanita Anders, PhD

Uniformed Services University of the Health Sciences

TLT's Procedure

TLT is delivered to 20 sites at the scalp relying on tissue scattering to expose more than 75% of the cortical surface



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810 nm CW laser produces heat buildup

810 nm CW laser

1. Hair is removed from the patient's scalp
2. The scalp is blanched during therapy – 2 PSI
3. The scalp is actively cooled during therapy – 19° C
4. Laser energy is applied to 20 locations for 120 seconds each

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Laser therapy protocol guidelines

- Laser dosage brain tissue: 5 J/cm^2 at target
- Treat local tissues - brain injury sites
- Treat supporting structures and functions
- Blood irradiation for systemic oxygenation

To compensate for tissue depth use the 50% rule

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Clinical case - neuroinflammation

- 77 years old
- 17 years in pain
- From neck down to ankles, worse in legs and buttocks
- History Rx: Amiltiptyline, Notriptyline, Lorazepam, Klonipin, Depakote, Buspar, Baklogen, Fentanyl patch, Zoloft, Prozac, Propranolol, Valium, Abilify, Tramadol, Cymbalta, and Shock therapy

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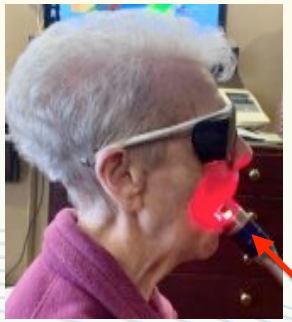
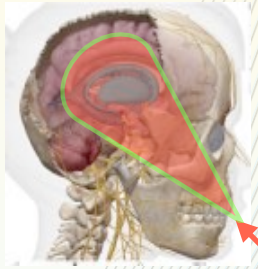
Clinical case - neuroinflammation





- Lumix 4 laser at 110 W pulse power and 40 kHz rate
- 0.5 W average power
- 10 minutes treatment time
- Twice weekly

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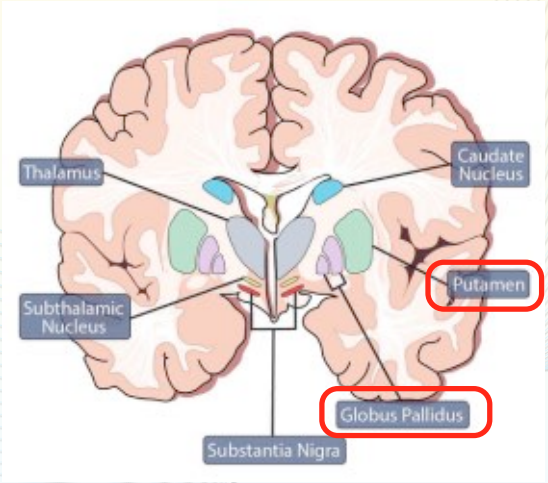
Supporting staructure: the basal ganglia



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Supporting structure: the frontal lobe

depth:
about 3 cm

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Frontal lobe treatment

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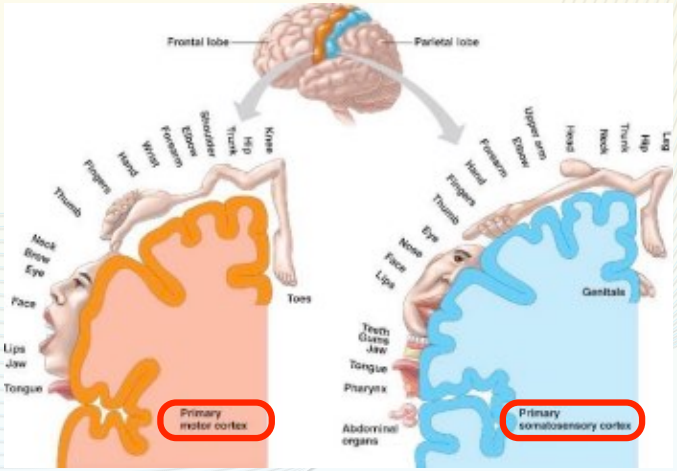
Centralized pain and motor issues



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Blood irradiation: putting photons in blood flow

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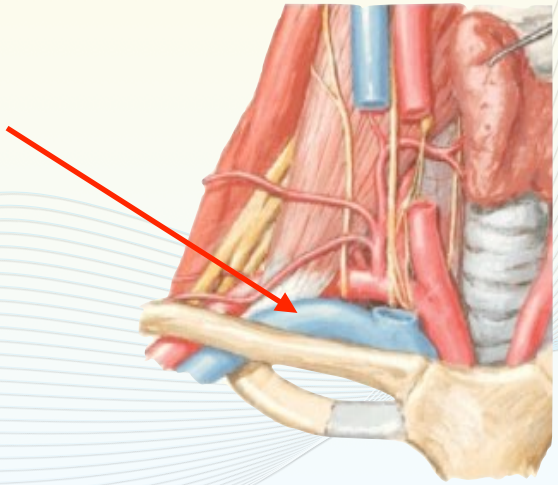
Blood irradiation: can use subclavian vein



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Temporal lobe treatment

Lumix 2 - 250W
Dr. T. Lahue, DC

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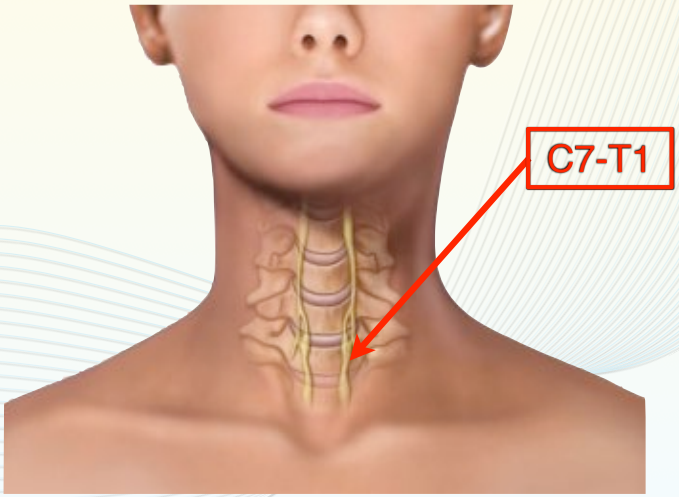
Supporting structure: Stellate ganglion



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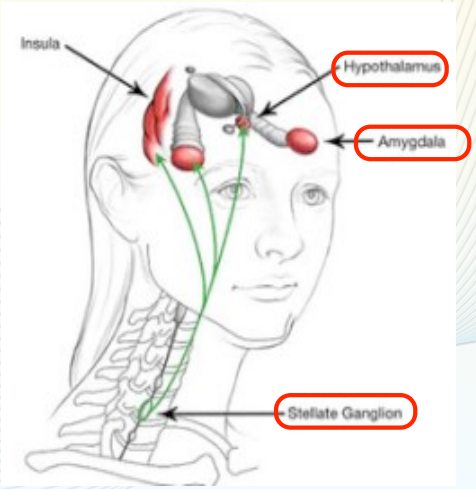
Stellate ganglion projections



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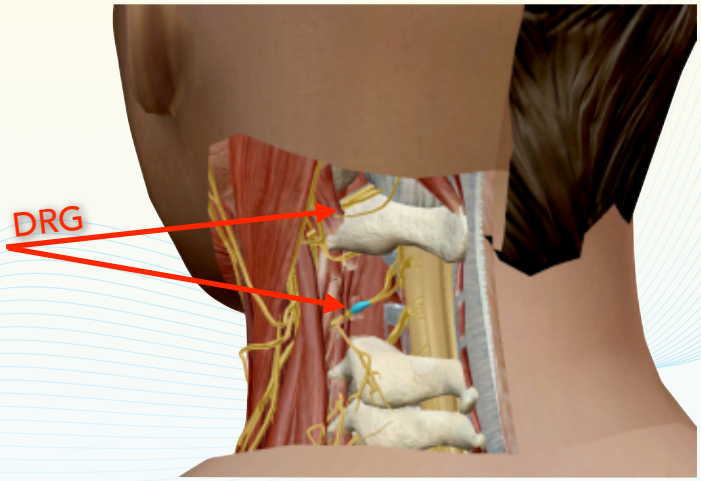
Treat C1 to T1 dorsal root ganglia



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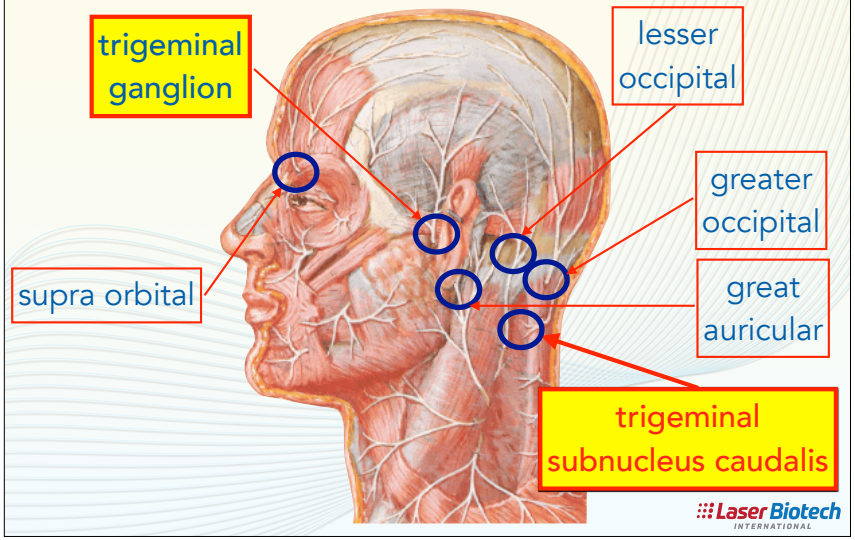
Migraines in TBI and concussions



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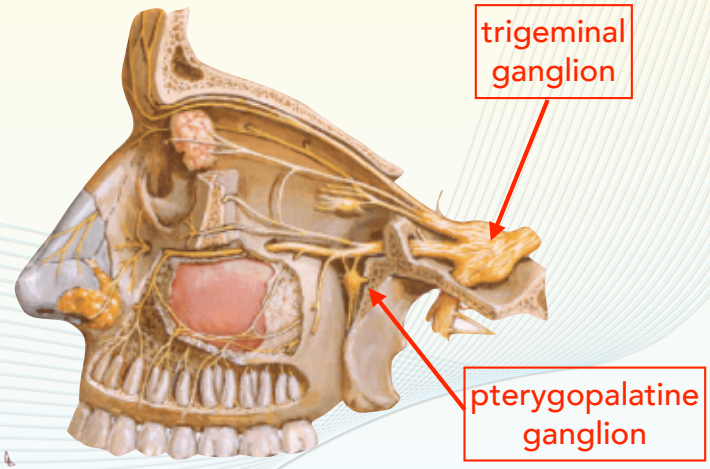
Trigeminal & pterygopalatine ganglia



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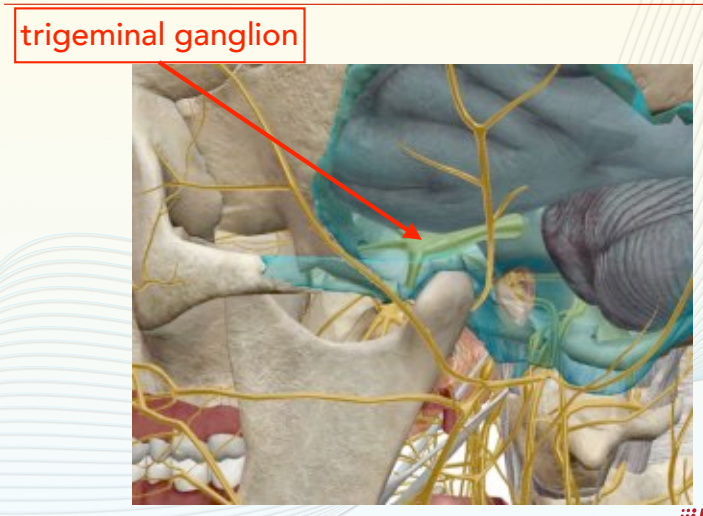
Line of sight to trigeminal ganglion



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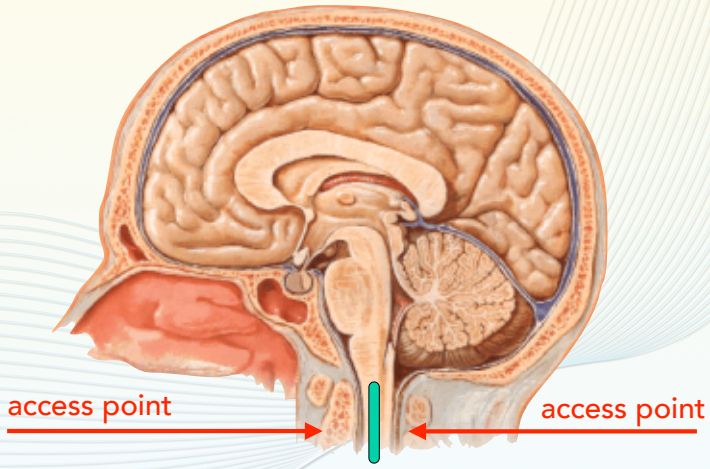
Targeting the CN V subnucleus caudalis



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Adjunct therapy: auriculotherapy

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Adjunct therapy: scalp acupuncture

NM & Toshio Yamamoto, MD, PhD

Excellent adjunct therapy for migraines

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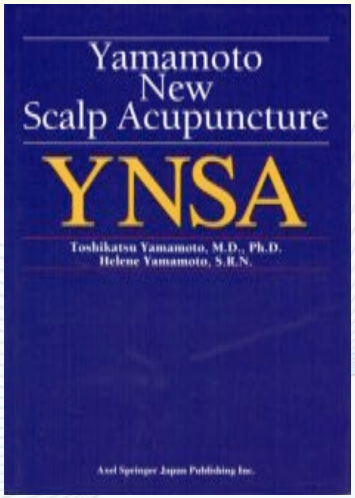
Adjunct therapy: scalp acupuncture



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Taking it back to the clinic

- Therapeutic lasers can be used for the reduction of inflammation in concussions
- Proper mitochondrial function is critical to treat neurodegeneration and for long-term tissue repair
- Concussions, in the chronic phase, are much more difficult to treat successfully
- Laser pulse rates of at least 30 kHz promote gene expression for tissue repair

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Taking it back to the clinic

- Most lasers recharge cellular mitochondria
- Reaching brain tissues without heating are crucial for effective treatment of TBI and concussions
- Tissue penetration is driven by high laser pulse power and appropriate wavelengths
- Blood irradiation is more than oxygenation - it recharges free-flowing mitochondria

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Taking it back to the clinic

- Some therapeutic lasers are able to safely penetrate tissues with low risk of thermal damage
- Some wavelengths produce higher thermal buildup than others
- Visible lasers are poor tissue penetrators
- Average power = amount of energy per second
- Energy = (average power) X (treatment time)
- Energy is what can damage tissues, not power!

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Lumix lasers can be used for neuroinflammation and tissue repair

Lumix 2, 3, 4 & 5

Lumix 2, 3 & 4

- 2 to 5 wavelengths from: 650, 810, 910, 980, or 1064 nm (tissue affinities)
- Pulse rate: 1 kHz to 100 kHz (gene expression)
- Average power: 0.5W to 35W (effective dose)
- Pulse power: 45W to 660W (tissue depth)

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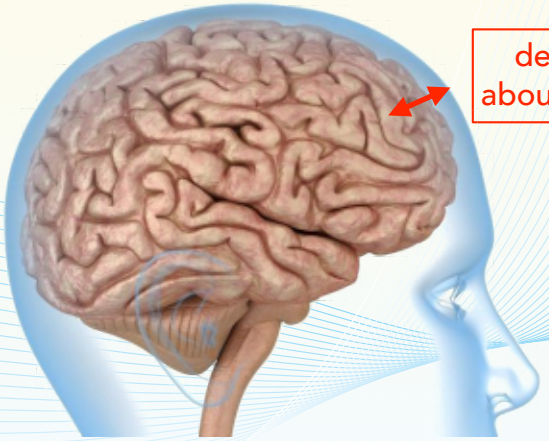
Brain: low thermal, high penetration!



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Laser with 132,000 W of pulse power

- Wavelengths: 650 and 1064 nm
- Pulse rate: 1 kHz to 100 kHz
- Average power: 0.5 W to 20 W
- Pulse power: 1,000 W to 132,000 W

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Recommended resources

- Laser Biotech webinars and online seminars
  - www.LaserBiotech.com
- World Association for Laser Therapy
  - www.WALTPBM.org

Seminar: Mastering Photonic Therapies
Wisconsin Chiropractic Association
Wisconsin Dells, September 19-21

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Recommended resources

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Webinar: craniocervical junction & TMD

The Craniocervical Junction & TMJ Pain: Treatment Strategies

Tuesday, August 20, 2024, 7:00 - 8:00 PM EDT, 1 CEU

UNIFIED VCA VIRGINIA CHIROPRACTIC ASSOCIATION

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Seminar: Virtual Neurology Summit

August 8 - 11, 2024

https://americanpostureinstitute.com/

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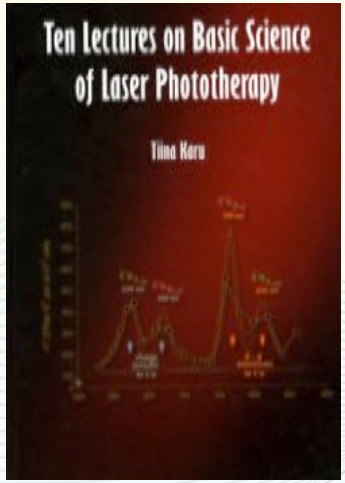
Dr. Karu: best laser researcher



NM and Tiina Karu, PhD

Dr. Karu discovered the role of cytochrome in laser therapy

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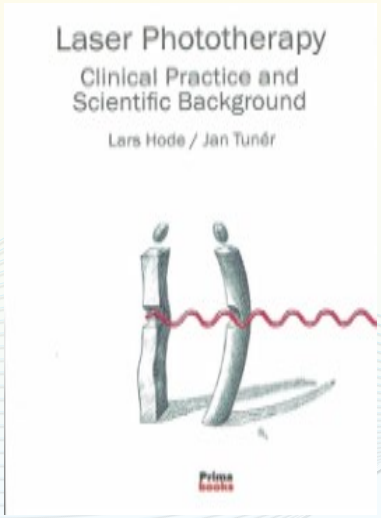
Recommended resources



NM and Lars Hode, PhD

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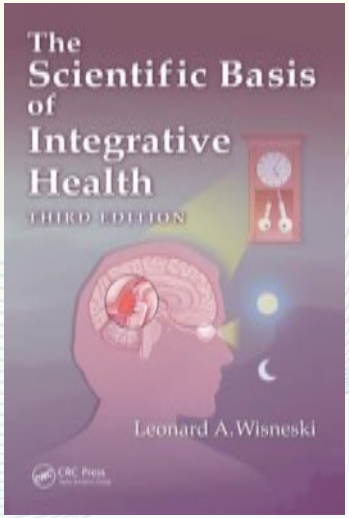
Recommended resources



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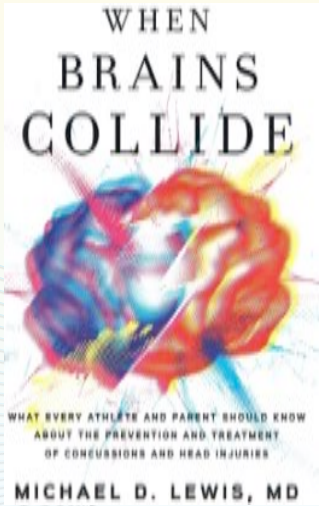
Recommended resources



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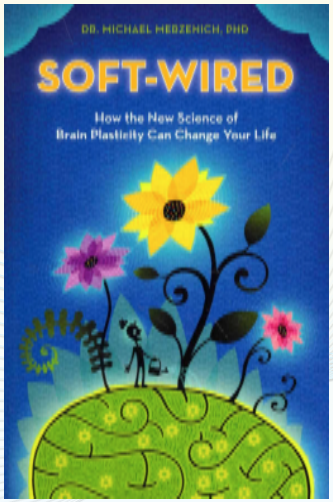
Soft-Wired = brain plasticity



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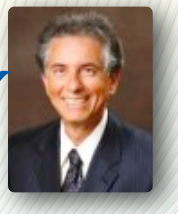
Traumatic brain injury and concussions:
laser therapy treatment guidelines

Nelson Marquina, MSc, PhD, DC
Laser Biotech International
Richmond, Virginia
www.LaserBiotech.com

Thank You!



UNIVERSITY OF BRIDGEPORT

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