STRATEGIES FOR IMPROVING PERIPHERAL NERVE REGENERATION AFTER SEVERE LESIONS: THE POTENTIAL ROLE OF LOW-LEVEL LASER THERAPY

Stefano Geuna, University of Torino, Italy

- Laboratory research

Why?
- Nerve fibers are subject to trauma
- CNS injuries 11,000; peripheral nerve injuries greater than 50,000
- Peripheral nerves (PNS) regenerate (can) spontaneously
- White matter fascicles (CNS) do not regenerate spontaneously
- His thesis
  - PNS regenerate more but almost never completely
  - CNS regenerate less, but almost never nothing at all
  - Because of this, both situations warrant rehabilitation

Peripheral Nerves
- Mild lesions do not require surgical repair
- Severe lesions require surgical repair

Surgical repair to re-establish nerve continuity
- No substance loss: suture, quite good but not lined up
- Substance loss: more complex,
  - Nerve graft (usually sacrifice a totally sensory nerve, like the sural nerve)
  - Stabilization: biological tube which allows the fibers to grow
  - Most severe: no more cell bodies, still have the distal nerve, or have the nerve cell but no distal nerve: can graft onto another nerve

Postsurgical rehabilitation
- Drugs
  - Hormones
  - Immunosuppressants
  - Gangliosides
  - Ca channel blockers
  - Neurotrophins
- PT
  - Exercise
  - US
  - Electrostim
  - Magnetic fields
  - Hyperbaric oxygen
  - Laser
- Others: stem cell transplants
Critical analysis of the literature on experimental studies for post-traumatic or other peripheral nerve injuries:

• Ten studies
• Rabbit studies more similar to humans, rats regenerate better than both: 80% rat, 20% rabbit, 70% mild nerve lesion
• Laser: more recently using semiconductors, 838-904 nm, -.31 to 162 J/cm, 90% continuous, 10% pulsed
• Treatment protocol: begin on first posttraumatic/operative day, 5-28 daily applications transcutaneously
• Outcome measures: functional evaluation, electro physiology, morphology
• RESULTS
  o 90% laser increased nerve repair process
  o 10% no detectable effect, but study limitations
  o 7 labs around the world

His study: worst lesion: transection requiring surgery, then laser after surgery, used rats, complete transection of left median nerve, repair by end-to side neurorrhaphy on the ulnar nerve, measured by grasping (only nerve that does)

• 3 times a week for 3 wks
• Continuous emission InGa(Ai)As laser 80 nm, 29 J cm/w
• Pulsed emission 905 nm, 40 J/cm2 Incas laser
• 4 groups: sham, continuous laser-TX, pulsed laser-TX, continuous pulsed combined laser TX
• The best results were with the combination of continuous and pulsed laser, next best with continuous, only a little improvement with pulsed, took 16 weeks—functional results combined gave 50% of normal function
• Muscle weight with the combined treatment was the same as control, as normal, the untreated lost 50% of mass
• The nerve fiber was 50% of normal size in the combo treated group
• SUMMARY:
  o Faster myelinization
  o Faster recovery of muscle trophism
  o Faster recovery of lesioned function
• What does LLLT do?
  o Stimulation of CA++ release and ATP synthesis
  o Neuroprotection, up regulation of TGF-beta 1, CGRP
  o Promotion of Schwann cell proliferation
  o Activation of the sprouting program distributed along the axon length (usually repressed)
• Early post-operative laser therapy should be regarded as a very promising rehabilitation tool for improving nerve regeneration after surgically repaired severe nerve lesions in patients.