Therapeutic Laser Evolution - Part 2

This is part two of the article that Doug Johnson presented in the last issue of Practical Pain Management (October 2008). I am pleased to have contributed to this article because it introduces a new technology that holds great promise for faster and more effective clinical results. I have been using combination laser/phototherapy and electrical stimulation for many months and am finding that has produced unique results beyond what I have previously observed.

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By Douglas Johnson, ATC, CLS and William Kneebone, RN, CRNA, DC

The recent introduction of Fourth Generation (G4) technology—mechanical and electrical laser hybrids—have inspired a whole new classification of light therapy and opened up a new realm of possibilities. These new technologies offer the promise of improved effectiveness and clinical outcomes.[1] However, the research supporting these new combinations remains sparse. One of the most intriguing of these new devices is the laser and electrical stimulation combination. Even with a lack of clinical trials, this newest of the G4 electrical modalities has some practical applications that all laser clinicians should be aware of.

Background

Both electrical muscle stimulation (EMS) and laser therapy have been studied extensively over the last few decades. EMS has long been a clinical favorite of therapists and staple of most rehabilitation centers. The use of transcutaneous electrical nerve stimulation (TENS) as a modality for pain relief that dates back to the 1960s—when it was used as a presurgical screening tool for patients with chronic pain in order to evaluate them for possible dorsal column stimulator implantation. Many of those patients experienced substantial relief and did not require dorsal column implatation.[2] One of first TENS studies was published in 1966 by Wall and Street.[3]

Studies historically refer to the gate control theory of pain to explain the effects of high frequency TENS.[4] The theory suggests that stimulating large diameter afferent fibers inhibits input from small diameter afferent fibers in the substantia gelatinosa of the spinal cord. A commonly held theory for the mechanism of action of low-frequency TENS is biochemical activation of endogenous opioid pathways. Analgesia produced by low-frequency, high-intensity TENS but not high-frequency, low-intensity TENS is reversed by administration of naloxone, an opioid receptor antagonist.[5] Increased concentrations of beta endorphins have been observed in the blood and cerebral spinal fluid of healthy patients after both low and high frequency TENS.[6,7]

Clinical studies of TENS have been done on a wide variety of painful disorders. With TENS, Melzack found an average reduction in pain of 75% following peripheral nerve injuries, 66% for phantom limb pain, 62% for should-arm pain, and 60% for low back pain following a brief, intense burst of TENS to trigger points or acupoints.[8] Likewise, Meyler et al[9] observed pain reduction in 211 patient with various types of painful conditions. These included favorable responses in 53% of peripheral nerve damage sufferers, 75% of ischemic heart disease patients, 69% of patients with mechanical/degenerative musculoskeletal disorders.[9] Long term pain relief in patients with chronic pain was evaluated by Fishbain et al[10] They interviewed 506 chronic pain patients that had purchased home TENS devices and found that 74.3% of them had used the devices for six months or longer. These users reported less pain at rest and during activity, decreased use of other therapies such as PT, Chiropractic, OT, etc, and decreased reliance on NSAIDs, opioids, anti-inflammatory drugs, or steroids.[10] Barr et al[11] found that age-related changes in the elderly did not significantly alter the applicability of TENS. There was no difference found in effectiveness or tolerance in these elderly patients with chronic pain.[10]

Laser therapy, with its minimal contraindications, is gaining some popularity in the rehabilitation market. Enwemeka et al found that laser therapy was highly effective for tissue repair and pain relief[12] and Ferreira et al demonstrated its positive effects on the inflammatory process.[13] These studies—combined with an ever expanding body of scientific evidence—validate the conclusion that radiation by red and near infrared light reduces pain by a combination of processes:

- increase in b-endorphins;
- blocked depolarization of C-fiber afferent nerves[14];
- increased nitric oxide production;

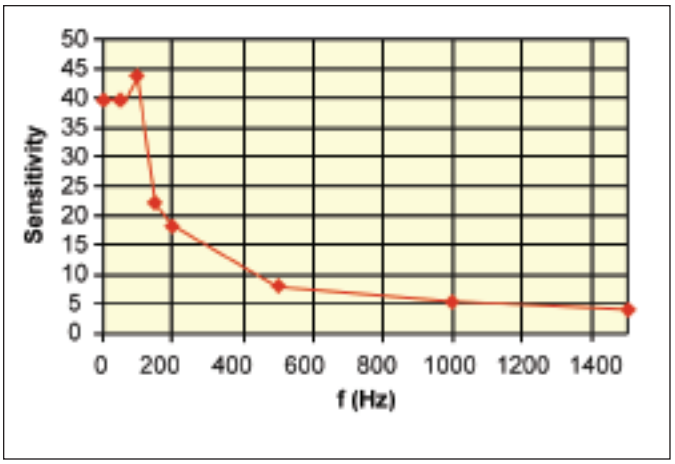

FIGURE 1. *Method sensitivity S=Zindif / Zactiv versus frequency*

- increased nerve cell action potential[15];
- axonal sprouting and nerve cell regeneration[16];
- decreased bradykinin levels;
- increased release of acetylcholine; and
- ion channel normalization.[17]

Though critics of phototherapy may continue to debate its overall effectiveness, the overwhelming scientific and clinical outcomes support the successful use of this new modality. Phototherapy has been shown to be effective in the management of ankle sprains,[18] Achilles' tendonitis,[19] shoulder tendonitis,[20] medial and lateral epicondylitis,[21] cervical pain,[22] and wounds/abrasions.[23]

Combined Therapy Effect

While their use as monotherapies has been extensively investigated, the combined application of both laser/light and electrical muscle stimulation research is just in the initial stages. Clinical trials of the FDA-cleared LaserStim[24] were conducted at the Burdenko Head Veterans/Military Clinical Hospital by V.M. Kliujev in Moscow, Russia. A group of 68 patients, suffering from osteochondrosis of cervical, thoracic and lumbosacral sections of the vertebral column and accompanied by moderate cervicalgia, thoracalgia, lumbalgia, were treated with a combined therapy of laser and LED radiation in a static magnetic field. In the case of acute pain syndromes, a pulse electrical current was used in addition to the magnetic field and laser radiation.

The researchers reported that all patients endured the treatment procedures and noted that, in the middle of the treatment course, the pain syndrome intensity significantly decreased and at the end of the course the pain syndrome essentially regressed while joint mobility increased. Myofascial pain syndrome associated with acute radiculitis was improved. In cases of radicular syndrome and polyneuropathy, greater improvement was provided by the use of light and infrared laser radiation in a static magnetic field in combination with a low frequency pulse electric current. A favorable therapeutic effect as a result of LaserStim use was obtained in 82% of patients with a satisfactory effect in 18% of patients. No negative results were observed.

G4 Hybrid Technology

Acupuncture shares some similarities to laser/light therapy applications. Many successful phototherapy treatment protocols are derived from acupuncture therapies.[25] In fact, Dr. Kneebone, in a prior article in this journal discussed a variation on laser therapy called laser acupuncture.[26]

Acupuncturists have long used impendence meters to locate acupoints. These acupuncture points have been found to be points of low electrical resistance compared to the surrounding tissue. The significance and detail of the local electrical properties of acupuncture points are uncertain at present.[27] For reliable detection of the acupuncture points it is necessary to establish a clear difference between normal skin and active points. At low frequencies (under 20Hz), the acupoint impedance is few multiples lower than the normal skin impedance, but it is very difficult to localize the point because, for a displacement of under 1mm, the measured impedance value drops to that for normal skin. At high frequencies (over 500Hz), normal skin impedance is very close to that of the acupoint, but transition from normal skin impedance to the acupoint impedance is smoother (see Figure 1). A good choice for the measuring frequency could be somewhere between 20 and 200 Hz, with 100 Hz being a good choice due to reduced measurement noise.[28]

Successful outcomes in laser/light therapy are directly related to providing an adequate dose to the target tissue. Though the concept seems simple, in fact, this is one of the most perplexing concepts for clinicians new to this technology. The most frequent question clinicians ask is "where" to apply the treatment. With success hinged on providing an adequate stimulus, improper target selection will result in lackluster outcomes.

One G4 hybrid—Multi Radiance Medical's LaserStim emitter—has not only incorporated both laser/light therapy and electrical muscle stimulation technologies into a single emitter (see Figure 2), but has included a built-in impendence meter to address target localization. This unit combines heat therapy with transcutaneous electrical nerve stimulation and is cleared by the Food and Drug Administration (FDA) for the following indications:

"…for temporary relief of minor muscle and joint pain, arthritis and muscle spasm, relieving stiffness, promoting relaxation of muscle tissue, and to temporarily increase local blood circulation where heat is indicated, as well as for the symptomatic relief and management of chronic, intractable pain and adjunctive treatment for post-surgical and post-trauma acute pain."[29]

Discussion

Beyond its therapeutic use, hybrid emitters offer utility that can be both practical and monetary. While the combination of both modalities may someday prove to be "beneficial" and therapeutic in its own right, the ability to locate and detect possible treatment targets is of tremendous interest to photoclinicians.

Overall success of any laser application is in the clinician's ability to locate potential targets. This has been typically done through assessment and should be a part of any light therapy application. Since targets are not always clearly discernible, the addition of an impendence meter in the head of the laser emitter may work to enhance the location process. This unique marriage of technology may improve overall efficacy of the laser application by ensuring proper target selection.

Reimbursement for light therapy has been a challenge, at best. Most clinicians struggle for adequate reimbursement for their laser sessions. The G4 technology may present a unique ability for clinicians to be reimbursed. Combination therapy billing may be the answer. Since the technology combines two forms of treat-

FIGURE 2. *LaserStim treatment of the right scapular region. Photo courtesy of Multiradiance Medical.*

ment, it should allow for the reimbursement of one of the procedures. In the case of the Laser/EMS combo probe where both are being applied simultaneously, the EMS portion may be billed under attended electrical muscle stimulation. Be sure to consult with a bonded coding specialist for additional information of this type of billing.

TENS Therapy Contraindications and Cautions

TENS is ineffective for pain of central origin and is of no curative value, per se. It is a symptomatic treatment that suppresses pain sensation which would otherwise serve as a protective mechanism and diminish positive outcomes of the clinical process.

TENS must *not* be used under the following circumstances:

- near demand-type cardiac pacemakers,
- on patients with known myocardial disease or arrhythmias,
- on the eyelids, over the carotid sinus nerves or arteries, laryngeal or pharyngeal muscles,
- for undiagnosed pain syndromes until etiology is established,
- in a manner that causes the current to flow transcerebrally (through the head).

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References

1. Zharov VP and Latyshev AS. Laser combined medical technologies from Russia. *Journal of Laser Applications*. April 1999. 11(2): 80-90.

2. Sluka K. The Basic Science Mechanisms of TENS and Clinical Implications. *APS Bulletin*. March/April 2001. 11(2).

3. Wall PD and Street WH. Temporary Abolition of Pain in Man. *Science*. 1967. 155: 108-109.

4. Melzack R and Wall PD. Pain Mechanisms: A New Theory. *Science*. 1965. 150: 971-978.

5. Sjolund BH and Eriksson MBE. The influence of naloxone on analgesia iproduced by peripheral conditioning stimulation. *Brain Research*. 1979. 173:295-301.

6. Hughes GS, Lichstein PR, Whitlock D, and Harker C. Response to plasma beta endorphins to transcutaneous electrical nerve stimulation in healthy subjects. *Physical Therapy*. 1984. 64: 1062-1066.

7. Salar G, Job I, Mingrino S, Bosio A, and Trabucchi M. Effect of transcutaneous electrotherapy on CSF b-endorphin content in patients with pain problems. *Pain*. 1981. 10: 169-172.

8. Melzack R. Prolonged relief of pain by brief, intense transcutaneous somatic stimulation. *Pain*. Dec 1975. 1(4): 357-373.

9. Meyler WJ, de Jongste MJ, and Rolf CA. Clinical evaluation of pain treatment with electrostimulation: a study on TENS in patients with different pain syndromes. *Clinical J of Pain*. Mar 1994. 10(1): 22-27.

10. Fishbain DA, Chabal C, Abbott A, Heine LW, and Cutler R. Transutaneous electrical nerve stimulation (TENS) treatment outcome in long term users. *Clinical J of Pain*. Sept 1996.12(3): 201-214.

11. Barr JO, Weissenbuehler SA, and Cleary CK. Effectiveness and Comfort of Transcutaneous Electrical Nerve Stimulation for Older Persons with Chronic Pain. *J of Geriatric Physical Therapy*. Dec 2004. 27(3).

12. Chukuka S, Enwemeka JC, Parker DS, Dowdy EE, Harkness LE, Harkness LD, and Woodruff LD. *Photomed and Laser Surgery*. Aug 2004. 22(4):323-329.

13. Ferreira DM, Zangaro RA, Villaverde AB, Cury Y, Frigo L, Picolo G, Longo I, and Barbosa DG. *Photomedicine and Laser Surgery*. Apr 2005. 23(2):177-181.

14. Tsuchiya K et al. Diode laser irradiation selectively diminishes slow component of axonal volleys to dorsal roots from the saphenous nerve. *Neuroscience Letters.* 1993. 161: 65-68.

15. Rochkind S et al. *Laser therapy as a new modality in the treatment of incomplete peripheral nerve injuries: Prospective Clinical Double-Blind Placebo-Controlled Randomized Study*. Department of Neurosurgery, Rehabilitation and Physiotherapy, Tel Aviv Sourasky Medical Center, Israel. Abstract from the 7th International Congress of European Medical Laser Association. Dubrovnik, Croatia. June 2000.

16. Byrnes KR et al. Cellular invasion following spinal cord lesion and low power laser irradiation. *Lasers Surg Med*. 2002. S14: 11.

17. Martin R. Laser-Accelerated Inflammation/Pain Reduction And Healing. *Pract Pain Mgmt*. Nov/Dec 2003. 3(6): 20-25.

18. Stergioulas A. Low-level laser treatment can reduce edema in second degree ankle sprains. *J Clin Laser Med Surg*. Apr 2004. 22(2):125-128.

19. Bjordal JM, Lopes-Martins RA, and Iversen VV. A randomized, placebo controlled trial of low level laser therapy for activated Achilles tendonitis with micro dialysis measurement of pretentious prostaglandin E2 concentrations. *Br J Sports Med*. Jan 2006. 40(1):76-80.

20. England S, Farrell AJ, Coppock JS, Struthers G, Bacon PA. Low power laser therapy of shoulder tendonitis. *Scand J Rheumatol*. 1989. 18(6):427-31.

21. Simunovic Z, Trobonjaca T, and Trobonjaca Z. Treatment of medial and lateral epicondylitis—tennis and golfer's elbow—with low level laser therapy: a multicenter double blind, placebo-controlled clinical study on 324 patients. *J Clin Laser Med Surg*. Jun 1998. 16(3):145-151.

22. Gur A, Sarac AJ, Cevik R, Altindag O, and Sarac S. Efficacy of 904 nm gallium arsenide low level laser therapy in the management of chronic myofascial pain in the neck: a double-blind and randomize-controlled trial. *Lasers Surg Med*. 2004. 35(3):229-235.

23. Hopkins JT, McLoda TA, Seegmiller JG, Baxter GD. Low-Level Laser Therapy Facilitates Superficial Wound Healing in Humans: A Triple-Blind, Sham-Controlled Study. *J of Athletic Training*. 2004. 39(3): 223-229.

24. FDA Clearance: K071445: Trade Name Device: LaserTENS, Multi Radiance Medical.

25. Ceccherelli F, Altafini L, Lo Castro G, Avila A, Ambrosio F, and Giron GP. Diode Laser in Cervical Myofascial Pain: A Double-Blind Study versus Placebo. *The Clinical J of Pain*. Raven Press, Ltd. New York.1989. 5:301-304.

26. Kneebone W. Laser Acupuncture As A Pain Relief Modality. *Pract Pain Mgmt.* May 2008. 8(4): 64-68.

27. Kazuhiko N et al. Basic study about analysis of skin impedance vector loci. *IEIC Technical Report*. 2001. 101(478): 63-70.

28. http://users.utcluj.ro/~mbirlea/m/04m.htm

29. LaserStim Operating Manual. Multi Radiance Medical. Solon, Ohio.