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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 a 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 implantation.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 by 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 percent following peripheral nerve injuries, 66 percent for phantom limb

THE EVOLUTION OF LASER THERAPY

New research studies combining e-stim and lasers for positive outcomes **By Douglas Johnson, ATC, EES, CLS**

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

pain, 62 percent for shoulder-arm pain, and 60 percent for low-back pain following a brief, intense burst of TENS to trigger points or acupoints.⁸ Likewise, Meyler et al observed pain reduction in 211 patients with various types of painful conditions.⁹

These included favorable responses in 53 percent of peripheral nerve damage sufferers, 75 percent of ischemic heart disease patients, and 69 percent 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 who had purchased home TENS devices and found that 74.3 percent 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 and others, and decreased reliance on NSAIDs, opioids, anti-inflammatory drugs or steroids.¹⁰ Barr et al found that age-related changes in the elderly did not significantly alter the applicability of TENS.¹¹

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 and Ferreira et al demonstrated its positive effects on the inflammatory process.^{12,13} 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;
- Increased nerve cell action potential;¹⁵
- Axonal sprouting and nerve cell regeneration;¹⁶
- Decreased bradykinin levels;
- Increased release of acetylcholine;
- 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 pain²² 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 LaserStim²⁴ were conducted at the Burdenko Head Veterans/Military Clinical Hospital in Moscow, Russia. A group of 68 patients suffering from osteochondrosis of the cervical, thoracic and lumbosacral sections of the vertebral column and accompanied by moderate cervicalgia, thoracalgia and lumbalgia,

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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 percent of patients with a satisfactory effect in 18 percent 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 discussed a variation on laser therapy called laser acupuncture.²⁶

Acupuncturists have long used impedance meters to locate acupoints. These acupuncture points have been found to be points of low electrical resistance compared to surrounding tissue. The significance and detail of the local electrical properties of acupuncture points are uncertain at present.²⁷ For reliable detection of 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 of 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.

A good choice for the measuring frequency could be somewhere between 20 and 200Hz, with 100Hz being a good choice due to reduced measurement noise.²⁸ Successful

TENS Therapy Contraindications, 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 transcranially (through the head).

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—a LaserStim emitter—has not only incorporated both laser/light therapy and electrical muscle stimulation technologies into a single emitter, but has included a built-in impedance 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 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 impedance 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 treatment, 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. ■

References are available at www.advanceweb.com/pt or by request.

Douglas Johnson is a certified athletic trainer with more than 11 years of clinical/industrial experience. He has worked extensively in occupational medicine as the assistant regional physical therapy director of Concentra Medical Center's Michigan Operations and as the therapy director of Prime-Care Medical Centers before co-founding a practice in 1996. He is the co-owner of Sports and Industrial Rehab and founder of the Laser Center of Michigan.



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