# Light Years

## Use current evidence to apply laser therapy for wound healing and pain relief

**By Roberta Chow, PhD, MB BS (Hons), FRACGP, FAMAC, MApplSci (Med Acu)**

**THE FIELD OF LASER THERAPY KEEPS EVOLVING AS CLINICIANS AND** researchers continue exploring potential uses and investigating the body's response to them.

Exploring non-thermal therapeutic applications of lasers began after the first production of a red laser from ruby crystals in 1960. Literature spanning the last 40 years provides evidence of significant effects of visible and infrared wavelengths on different cell types. Over time, therapeutic applications have followed parallel courses, which include wound healing, pain modulation and laser acupuncture, and provide insight into the diverse clinical effects of lasers.

Low-level laser therapy (LLLT) uses light with the specific characteristics—single wavelength, coherence and parallelism—to treat medical conditions. Historically, different terms have been used for LLLT, such as cold laser, low-power laser therapy and photobiomodulation.

Laser devices with "low" output produce therapeutic effects by non-thermal absorption of photons by cells. These actions are in contrast to high-power lasers in surgery, where a focused laser beam produces intense heat to vaporize tissue.

The absorption of photons by enzymes within the respiratory chain of mitochondria is the primary event by which the electromagnetic energy of a laser is transduced into electrochemical and electrophysical effects.[1] These actions initiate a cascade of secondary intracellular events that alter cell-specific functions, inducing tertiary physiological changes in tissues that cause therapeutic benefits, such as wound healing, pain relief and tissue repair.

### Enhancing Wound Healing

Enhancing wound healing was one of the earliest clinical applications of laser therapy. Endré Mester, a Hungarian physician, applied a ruby laser to treat leg ulcers of varying etiology. His study of more than 2,000 patients with intractable ulcers demonstrated the healing effects of lasers, especially venous ulcers, and provided the rationale for research that followed. Many studies, including randomized controlled trials (RCTs) of wound healing, have been performed.

Clinicians have some understanding of mechanisms for laser-induced wound healing after studying the effects of lasers on fibroblasts, macrophages and other cells critical to tissue repair. Studies of fibroblast cultures provide evidence that lasers absorbed by the mitochondria stimulate ATP production to initiate intracellular events, such as increased mitosis and procollagen formation.

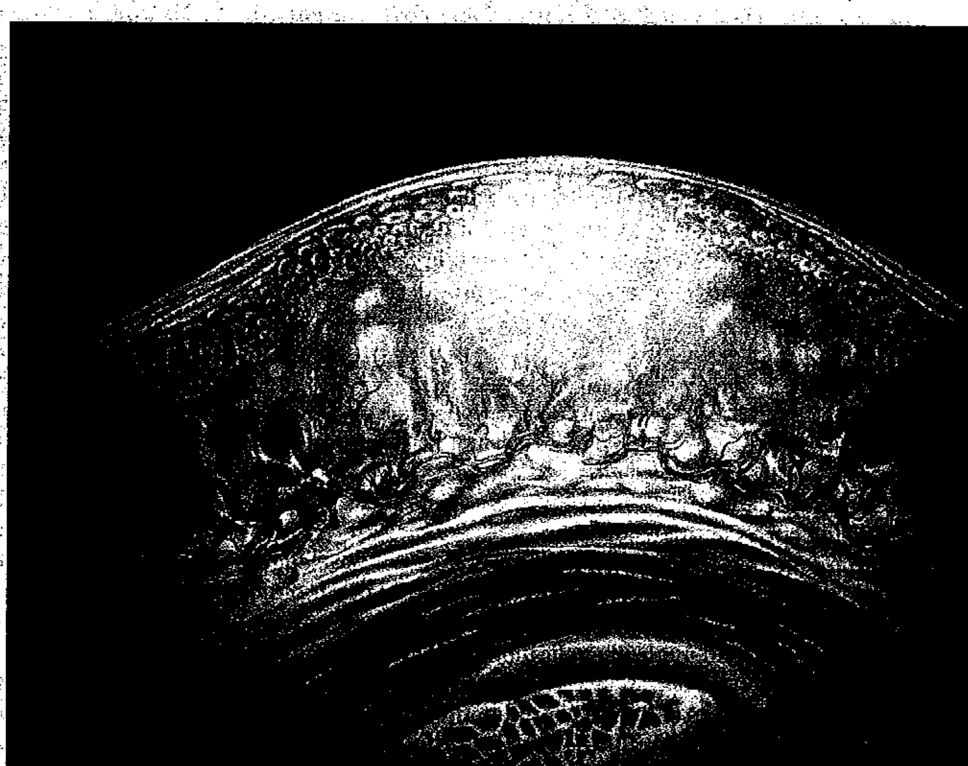
Micro-DNA studies of laser effects on fibroblasts demonstrate up- and down-regulation of 111 genes associated with fibroblast activation and tissue repair.[2] In macrophages and neutrophils, lasers modulate several functions, including phagocytic activity and degranulation.

Although in-vitro studies demonstrate stimulation of cell function and RCTs show enhanced wound healing, not all studies show benefits. And that leads to conflicting findings in meta-analyses.[3,4] The intrinsic complexity of laser therapy is illustrated by these studies, since the heterogeneity of laser parameters and wavelengths is a major factor in the diverse outcomes. From these studies, it appears that visible wavelengths may be more effective than infrared wavelengths to stimulate tissue repair. As such, the importance of appropriate laser parameters is paramount.

### Improving Pain

Research into the pain-modulating effects of lasers followed a path similar to wound healing, with evidence for the efficacy of LLLT for painful clinical conditions steadily accumulating in recent years. Meta-analyses and systematic reviews reveal that lasers can be effective for chronic joint disorders, chronic pain, rheumatoid arthritis and neck pain.[3,5-12] Single RCTs and published case series for painful conditions suggest the possibility of broad clinical applications for laser therapy.

Recent research provides an understanding of mechanisms for pain relief. Researchers have identified anti-inflammatory effects



JENNIFER SCHOERKE

across a range of laser wavelengths and doses. Evidence also suggests that infrared wavelengths may have selective, inhibitory effects on nociceptors, block fast axonal flow in A and C fibers and cause a reversible neural blockade.[13]

Tissue repair can also produce long-term benefits to relieve chronic pain conditions. Understanding how each of these effects interacts to relieve pain is the subject of ongoing research.

**Examining Laser Acupuncture**

Laser stimulation of acupuncture points is a different application from its use for wound healing and pain. In laser acupuncture, the laser "needle" stimulates acupuncture points in the skin, comparable to metallic needles. This action activates acupuncture pathways from the spinal cord to the cortex.

It's essentially a neural stimulus that requires detailed knowledge of the location of function-specific, anatomically defined points. This is in contrast to the effects of lasers in tissue repair and pain modulation, which rely on the direct effects of a laser on targeted tissue.

In addition, there's no sensation with laser acupuncture; sensation is thought to be a prerequisite for effective acupuncture. Unlike the pain-relieving effects of needle acupuncture—which can be blocked by Naloxone—laser acupuncture is only partially blocked, suggesting somewhat different mechanisms.

The noninvasive nature of laser acupuncture is a clinical advantage because there are no risks of skin penetration. Therefore, it's considered safe. The evidence base is less well-developed for laser acupuncture, although it is widely used.

But it can be challenging to understand and apply current evidence. Laser therapy has attracted controversy since its earliest clinical applications. Aside from current evidence-based medical applications of non-thermal light to treat neonatal bilirubinemia, psoriasis or seasonal affective disorder, the proposal that a laser could induce significant clinical effects has been viewed skeptically.

However, evidence supports laser-induced alterations in cell physiology in a range of cells. At the other end of the spectrum, while the evidence for clinical applications is more limited, several systematic literature reviews and meta-analyses provide evidence of the benefits.

**Studying Laser-Related Factors**

Several factors in laser therapy make clinical research and applications intrinsically complex, which helps account for diverse findings. These factors can be grouped into two broad categories: laser-related and patient-related. You need to understand these categories to evaluate the effectiveness of laser therapy.

The most important laser-related factors include: wavelength, which can be divided into visible and infrared; output power of the laser (from milliwatts to watts); duration of application (from seconds to minutes); and mode of application, such as in contact with the skin or scanned from a distance. Using a drug analogy, combinations of each of these parameters constitute the laser "dose," while the wavelength is considered the "class" of drug. Identifying the optimal combination of these parameters for specific indications is necessary to achieve the best clinical outcome.

For instance, optimal parameters have been identified to treat tendinitis and osteoarthritis.[14] However, these methods haven't been established for many other conditions and RCTs fail to describe laser parameters, which makes it difficult to assess laser "dose."

The complex interaction of laser parameters in clinical applications is the basis for many disparate study outcomes. Patient-related factors, which vary from person to person, report positive responses to laser therapy. Although they aren't clearly understood, they include the melanin content of skin, thickness of subcutaneous fat and muscle tissue, and depth of target tissue. Each component influences penetration of a laser "dose."

**[ Several factors in laser therapy make clinical research and applications intrinsically complex, which helps account for diverse findings. ]**

Laser therapy offers potentially important clinical advantages that make its empirical use acceptable, even in areas where evidence is still accumulating. The evidence for topical anti-inflammatory effects of lasers is strong and important in an environment where the adverse effects of oral NSAIDs are associated with high morbidity and costs.

Indeed, the demand for non-drug options is an important stimulus for exploring the place of laser therapy for chronic conditions, such as rheumatoid arthritis and osteoarthritis. In addition, the finding that lasers can cause a noninvasive neural blockade has important implications for managing a range of painful conditions. For instance, therapeutic options for treating nonhealing ulcers are limited and lasers show potential to offer an additional modality for stimulation of tissue repair.

New therapeutic applications of laser therapy are being explored in experimental models, such as peripheral nerve repair, spinal cord regeneration, stroke and myocardial infarction. Extending research into human clinical trials may offer new treatment options.

Understanding and evaluating the range and complexity of clinical applications of laser requires high-quality research. Presently, the low risk, coupled with demonstrated benefits in many RCTs, provide clinicians with an opportunity to exercise clinical judgement with laser therapy.

But the concept of light as a therapeutic modality requires a paradigm shift from a drug-centered medical practice. The basic science of light-tissue interaction is becoming clearly elucidated, which enables applications to expand. Accepting laser therapy as a mainstream medical modality depends on continuing research at basic science and clinical levels in order to set the platform for a new branch of medicine. ■

**References are available at www.advanceweb.com/pt. Select "References" on the left menu bar.**

*Roberta Chow is a general practitioner with a special interest in pain management using laser therapy. She recently completed her PhD at the University of Sydney in Australia, after studying the effects of laser therapy on neck pain and exploring possible mechanisms of pain relief. She can be reached at rtchow@bigpond.net.au*