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A Brief History of Laser Therapy

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1st Edition Contributor:

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Treatment with Light

Heliotherapy. Phototherapy. Light therapy. Cultures around the world have attributed many names to this remedy as they have practiced it in various forms over the past several millennia. Healers in Egypt and India used sunlight to treat leucoderma 3500 years ago (Hönigsmann, 2013). Physicians in Ancient Greece and Rome – including renowned Greek historian Herodotus in the sixth century BCE, and Hippocrates, the father of medicine – also realized the benefits of such therapy (Ellinger, 1957). Likewise, the Inca and Assyrian cultures worshiped the sun with the belief that it would bring them health. There are records in the Buddhist literature from around 200 CE and Chinese documentation from the tenth century recording similar therapeutic effects from light.

Niels Ryberg Finsen, a Faroese physician and scientist of Icelandic descent, is widely regarded as the original proponent of phototherapy. In 1903, he was awarded the Nobel Prize in Medicine and Physiology for the successful treatment of diseases using phototherapy, specifically lupus vulgaris, a skin infection caused by *Mycobacterium tuberculosis* (Nobel Prize, 2014b). He also famously utilized ultraviolet light to treat smallpox lesions (Nobel Lectures, 1967).

A Closer Look

In the seventeenth century, Sir Isaac Newton discovered that prisms could disassemble or separate white light into seven different visible colors, a phenomenon he described in his book *Opticks* (Newton, 1704). Newton first used the word

spectrum (Latin for “appearance” or “apparition”) while describing refracted light in 1671. Today we also use another word to describe these and other colors of light: *wavelengths*.

In 1916, Albert Einstein made several hypotheses to support his theory of relativity. Einstein proposed that an excited atom in isolation can return to a lower energy state while emitting photons, a process he termed “spontaneous emission.” Other atoms will absorb such photons of the correct wavelength; causing those atoms to enter a higher-energy state and setting the stage for further spontaneous emission.

Einstein then predicted that as light passes through a substance, it stimulates the emission of more light (Hilborn, 1982). Einstein’s theory hypothesized that a large collection of atoms already containing a great deal of excess energy will be ready to emit photons – photons that prefer to travel together in the same state. If one such stray photon of the correct wavelength passes by an atom already in an excited state, its presence will stimulate that atom to release its own photons early. The new photons will then travel together in the same direction as the original stray photon, with identical frequency and phase. A cascading effect could thus ensue: As the identical photons move through other atoms, ever more identical photons are emitted (Pais, 1982). Einstein termed this phenomenon “stimulated emission,” postulating the theory of laser light 43 years prior to its realization.

A Momentous Device

On May 16, 1960, Theodore Maiman produced the first laser device at the Hughes Aircraft Research Laboratory in Malibu, California, using a simple flashlamp to stimulate

a solid medium (a ruby rod) to emit collimated photons of coherent light. At a press conference to announce his invention, he predicted that such a light would be useful in medicine and surgery (Hecht, 2005). Maiman based his invention on Albert Einstein's explanation of stimulated emission of radiation, coupled with Charles Townes's and Arthur Schawlow's work with optical masers (Schawlow and Townes, 1958; Itzkan and Drake, 1997). The acronym LASER (Light Amplification by Stimulated Emission of Radiation) itself was first coined and recorded by Townes's graduate student Gordon Gould. Gould's subsequent struggles for recognition for his work with lasers would result in one of the most lengthy, controversial, and important patent battles in US history (Taylor, 2000). Meanwhile, advancements in the development of laser media and devices within other industries would indeed lead to new applications of lasers in medicine and surgery over the following decades.

Subsequent studies revealed that particular wavelengths of laser light could be produced by stimulating particular laser mediums. The first diode laser, utilizing coherent light emission from a gallium arsenide (GaAs) semiconductor diode, was revealed in 1962 by two groups: Robert N. Hall at the General Electric Research Center (Hall *et al.*, 1962) and Marshall Nathan at the IBM T.J. Watson Research Center (Nathan *et al.*, 1962).

In 1962, other teams at the MIT Lincoln Laboratory, Texas Instruments, and RCA Laboratories also demonstrated the emission of light and lasing in semiconductor diodes. Early in 1963, a team led by Nikolay Basov in the Soviet Union utilized GaAs lasers to achieve emission of light (Nobel Prize, 2014a).

In 1970, the first laser diode to achieve continuous-wave (CW) emission was revealed simultaneously by Zhores Alferov and his collaborators in the Soviet Union, and by Morton Panish and Izuo Hayashi in the United States (Ghatak, 2009). However, it is widely accepted that Alferov and his team reached the milestone first, and they were consequently awarded the Nobel Prize in Physics in 2000.

While many types of therapeutic lasers were in use around the world, it was not until 2002 that Class IIb lasers gained Food and Drug Administration (FDA) approval for therapeutic purposes in the United States. These lasers are colloquially referred to as "cold lasers" or "low-level laser therapy" (LLLT) devices. They are limited to 500 mW and are considered effective in the treatment of superficial conditions. The term "cold lasers" refers to the lack of a heating effect on tissue cultures in early experiments, while the term "LLLT" helped to differentiate low-power therapeutic lasers from surgical lasers.

Class IV therapy lasers, operating in excess of 500 mW, were approved by the FDA in 2006. This was the dawn of

"high-power laser therapy" (HPLT). Delivery systems and precise dosage software have evolved (over the past several decades) to allow the safe and effective delivery of 500 mW–60 W to target tissues.

An Innovative Therapy

Just a few years after the invention of the laser, Dr. Endre Mester became the first to experimentally document its healing effects. Because he used mice as his experimental model, this is also the first documented use of lasers to accelerate healing in veterinary medicine (Mester *et al.*, 1967). Considered the founding father of laser therapy for his pioneering work, Dr. Mester's experiments would also later prove that the acceleration of healing was actually a systemic event rather than merely a localized one (Perera, 1987). Mester observed a cascading effect of the healing process, motivating other researchers in Western and Eastern Europe to recognize the value of laser therapy and initiate studies of their own.

Early in the 1970s, the use of laser therapy was documented in Eastern Europe, China, and the Soviet Union; much of the early research emanates from these geographical regions. Over the next decade, the use of laser therapy spread to Western Europe and became accepted as an effective physical therapy modality (Goodson and Hunt, 1979).

Yo Cheng Zhou, an oral surgeon in China, was the first to stimulate an acupuncture point with a laser. He used laser stimulation instead of standard local anesthetic protocols during routine dental extractions. A beam from a 2.8–6.0 mW helium-neon laser apparatus (Model CW-12, Chengdu Thermometer Factory) was applied for 5 minutes before the removal of a tooth (Zhou, 1984).

From the mid-1970s to the early 1980s, laser therapy became an accepted physical therapy modality throughout Western European and several Asian countries. It finally appeared in the United States around 1977, but there were only a small number of therapists who understood its potential. Laser equipment in the United States during this time frame was limited to the 1–5 mW range, and acceptance by the medical and veterinary professions was very limited due to inconsistent clinical results. Extensive *in vitro* studies of the effects of various wavelengths of light on cell cultures was conducted throughout the 1980s and 1990s by researchers such as Dr. Tiina Karu, leading to a closer study of photoacceptors and the mechanisms of action of laser therapy (Karu, 1987). Laser therapy's association with cytochrome c oxidase and nitric oxide continues to be studied in innovative ways (Wong-Riley *et al.*, 2005).

The first Independent Institutional Review Board for Laser Acupuncture Research was established in 1993, based on research compiled by Margaret Naeser, Ph.D.,

Lic.Ac. through the Robert Wood Johnson Foundation of Princeton, New Jersey. This initiated the effort and motivation of several colleagues to compile enough current information and research to be in compliance with US FDA regulations. Dr. Naeser has since published papers on utilizing laser therapy in stroke cases (Naeser and Hamblin, 2011).

A New Name

The history of laser therapy and the development of laser therapy devices have produced confusing terminology. Multiple terms initially and rapidly sprang up to describe both this technology and its utilization, each of them often lacking adequate scope of the therapy they attempted to relate. Many such terms were more representative of the devices being used than of the therapy itself being provided.

Several associations have formed over the years to encourage scientists and practitioners to exchange knowledge and information on laser therapy. The American Society for Laser Medicine and Surgery (ASLMS), formed in 1981, was the first. It was the dream of its founders that this organization be unique and include physicians, clinicians, and outstanding researchers in the areas of biophysics, biochemistry, biomedical engineering, laser biology, and laser safety. In 1994, the World Association for Laser Therapy (WALT) was formed by combining the International Laser Therapy Association (ILTA) and the International Society for Medical Laser Applications (ISLA). The North American Association for Laser Therapy (NAALT) was established in 1998. It included the regions of Mexico, Canada, and the United States of America. In 2015, the association changed its name to the North American Association for Photobiomodulation Therapy, retaining the same acronym, NAALT. These organizations share the same common goals: improving the understanding of photobiological mechanisms, promoting research, establishing treatment and regulatory guidelines, and providing education, clinical applications, and new clinical techniques.

Recognizing that an accurate, clear, and unambiguous name was needed, 15 international participants joined in a nomenclature consensus meeting at the joint conference of NAALT and WALT in September 2014 (Anders *et al.*,

2015). Respected authorities Dr. Jan Bjordal and Dr. Juanita Anders co-chaired the meeting. The term “photobiomodulation therapy” (PBMT) was recognized as being most descriptive of a science that involves complex mechanisms, some that are stimulatory, some inhibitory. Since that meeting, the National Library of Medicine (United States) has added the term “photobiomodulation therapy” to the MeSH database (MeSH, 2016).

The committee defined the term photobiomodulation therapy as

“A form of light therapy that utilizes non-ionizing forms of light sources, including lasers, LEDs, and broadband light, in the visible and infrared spectrum. It is a nonthermal process involving endogenous chromophores eliciting photophysical (i.e., linear and nonlinear) and photochemical events at various biological scales. This process results in beneficial therapeutic outcomes including but not limited to the alleviation of pain or inflammation, immunomodulation, and promotion of wound healing and tissue regeneration.” (Anders *et al.*, 2015)

Older terminology continues to be used even as photobiomodulation therapy becomes more commonplace in publications and practical applications. In this text, the terms “laser therapy” and “photobiomodulation therapy” (or simply “photobiomodulation,” PBM) will be used interchangeably.

A Better Tomorrow

As thousands of veterinary practitioners around the world continue to adopt laser therapy into their practices and a wealth of evidence regarding the use and efficacy of laser therapy continues to be published, we as veterinarians should continue to be at the forefront of this scientifically and clinically proven modality. Continued collaboration and sharing of information between us is essential to the future development of this advanced medical technology. We invite you to be a part of both this distinguished history of laser therapy and the new developments within this burgeoning field, which tomorrow’s veterinarians will continue to quote in the future.

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