

# Practical

VOLUME 7, ISSUE 4  
MAY 2007

# PAIN MANAGEMENT

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# Deep Penetration Therapeutic Laser

The Gallium Arsenide (GaAs) infrared laser provides the deepest penetration of body tissue of any laser currently available and can be utilized in treating a wide range of painful conditions.

by William J. Kneebone, RN, CRNA, DC, CNC, DIHom, FIAMA, DIACT



Painful conditions that can therapeutically benefit from laser irradiation are associated with pain generators found at varying tissue depth, ranging from relatively shallow target tissues (skin, subcutaneous structures, etc.) to much deeper tissues. GaAs therapeutic lasers are useful for anti-edema and lymphatic effects, treating painful conditions of the skin and subcutaneous tissues, wound healing, anti-inflammatory effects, and tissue regeneration. GaAs lasers can also provide the same therapeutic results for deep tissue structures—such as facet joints, acetabular joints, herniated discs, etc.

Gallium Arsenide (GaAs) therapeutic lasers present an interesting challenge when applying them to tissues of varying depths and when attempting to achieve different therapeutic effects. GaAs laser diodes penetrate more deeply than any other commonly used therapeutic laser.<sup>1</sup> This phenomenon is largely a result of the fact that the GaAs diode operates at a wavelength of 904 nm or 905 nm and is also due to its superpulsing mode of energy delivery. I explained in a previous article that the higher the wavelength of a therapeutic laser, the deeper the penetration.<sup>2</sup> Superpulsing is a mechanism whereby there are continuous bursts of very high power pulses of light energy (10-100 Watts peak power) that are of extremely short duration (100 – 200 nanoseconds/Hertz). This works something like a camera flashbulb. Superpulsing allows the mean or average power output to be relatively low—when compared to continuous wave output therapeutic lasers—and still achieve deep tissue penetration, as well as comparatively short treatment times.<sup>3</sup> The GaAs laser penetrates to tissue depths of 3–5 cm and deeper.<sup>4</sup> There are even some versions of GaAs therapeutic lasers that actually penetrate to tissue depths of 10–14 cm.<sup>5</sup>

In this article, I will discuss ways to obtain maximum treatment effects utilizing this type of laser.

## Review of Laser Effects

I discussed in a previous article that there were three different types of effects that therapeutic lasers have in the body. They are:

**TABLE 1. FREQUENCY VS. THERAPEUTIC EFFECT**

| Frequency Range | Therapeutic Effect   |
|-----------------|--|
| 1000-3000 Hz    | anti-edema effects; lymphatic system circulation; skin treatment   |
| 1000 Hz         | analgesia for chronic pain; painful conditions of the skin; wound healing  |
| 50 Hz           | anti-inflammatory; analgesia effect on subcutaneous tissues, fascia, tendons, and small joints   |
| 5 Hz            | deepest penetration; effective treatment of deeper tissue structures, including facet joints, acetabular joints, herniated discs; tissue regeneration. |

**TABLE 2. PULSE FREQUENCY SETTINGS**

| Diagnosis           | Frequency Range |
|---------------------|-----------------|
| Pain, neuralgia     | 1-100 Hz        |
| General stimulation | 700 Hz          |
| Edema, swelling     | 1000 Hz         |
| General stimulation | 2500 Hz         |
| Inflammation        | 5000 Hz         |
| Infection           | 10000 Hz        |

After Tuner and Hode (courtesy of Doug Johnson, ATC, CLS)

**Primary effects** — created by direct photoreception of photons with cytochromes resulting in increases in ATP production and changes in cell membrane permeability; this response is specific to phototherapy. Photoreception is generally followed by transduction of the signal and a photo-response—the last of which can be classified as either secondary or tertiary.

**Secondary effects** — occur in the same cell in which photons produced the primary effects; they are induced by these primary effects. Secondary effects include cell proliferation, protein synthesis, degranulation, growth factor secretion, myofibroblast contraction, and neurotransmitter modification—depending on the cell type and its sensitivity. They are less predictable than primary effects; the sensitivity of the cells are dependent on internal and external environment factors.

**Tertiary effects** — indirect responses of distant cells to changes in other cells that have interacted directly with photons. They are the least predictable because they are dependent on both variable environmental factors and intercellular interactions. They are, however, the most clinically significant. Tertiary effects include all the systemic effects of phototherapy.<sup>7</sup>

Therapeutic lasers can be applied in such a way as to stimulate any or all of these three effects.<sup>8</sup> These effects are achieved when using a GaAs laser by using various frequencies.<sup>9,10</sup> In fact, the standard method for achieving successful treatment of various tissues, at varying depths, is by utilizing different frequencies.<sup>6,7</sup>

### Frequency Selection for Specific Therapeutic Effects

I will now discuss the specifics of each frequency commonly used when treating with GaAs laser so that the best therapeutic effects can be achieved. These frequencies and resulting therapeutic effects are summarized in Table 1.

Frequencies that several other researchers have observed to be therapeutic for specific diagnoses are presented in Table 2.

### 1000–3000 Hz. Frequency Range

This frequency range has been shown to have anti-edema effects and a profound effect on the lymphatic system<sup>11</sup> and is characterized as a systemic or tertiary effect.

When attempting to treat an edematous area it has been found to be important to treat the lymph nodes proximal to the edematous site with the laser. This opens up the lymph vessel and allows more rapid reduction of the local edema. This technique is known as Oshiro's Principle (see Figure 1).

The 1000 – 3000 Hz. frequency range has been also been found to be effective

in treating the skin. This frequency range has been shown to stimulate collagen production and help resolve scar tissue. These are examples of local tissue effects.

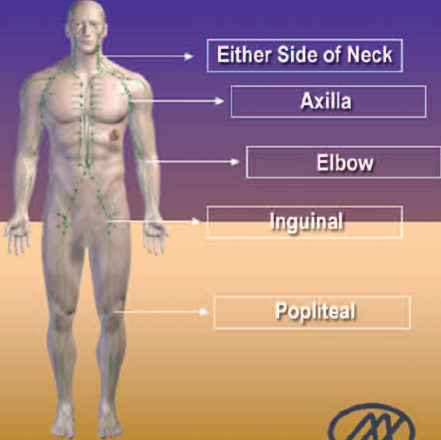
### 1000 Hz Frequency

This frequency is commonly used to produce analgesia, especially in pain of more chronic duration<sup>12</sup> and is characterized as a systemic effect. Trigger Point reduction

## Treatment of Edema: Oshiro's Principle

**Swelling of Extremity**

- "Oshiro's" proximal priority principle. Treat proximal sites for drainage first to open pathway then distal injury last.
- If distal is treated first, lymph accumulation increases because proximal injury prevents drainage and there is increased pain.



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FIGURE 1. Lymphatic Technique (courtesy of Doug Johnson ATC, CLS)


## Treatment of Trigger Point / Muscle Spasms: Pontinen's Principle

**Trigger Points**

- Pontinen's Principle is designed to maximize treatment response in a single visit and to ensure that sufficient dosage has been provided.

**Technique**

- Palpate area, rate pain, treat the painful area (6-8 J/cm<sup>2</sup>), reassess for pain response and retreat if no response at all. Up to 2 more reapplications of energy may be given.



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FIGURE 2. Trigger Point Techniques (courtesy of Doug Johnson, ATC, CLS)

### Case Illustration

This patient presents to the office with complaints of acute ankle pain of moderate to severe intensity, pronounced swelling (edema) over the medial and lateral malleolus, and redness and heat observed in the entire ankle area. A specific treatment protocol with the GaAs laser would be to start with a variable frequency setting first, such as 5–50–100–1000 Hz in an attempt to stimulate rapid beta-endorphin stimulation and C-fiber blockade. A frequency range of 1000–3000 could next be used to obtain an anti-edema effect, remembering to treat the inguinal lymph nodes first in order to open up the lymph channel. The third frequency utilized during this treatment session is 50 Hz. for continued pain reduction and an anti-inflammation effect. We have specifically addressed the acute pain, edema, swelling and other inflammatory effects—all during this visit. The exact treatment protocols will change with each visit depending on the patient's response to the previous treatment. It is recommended to use frequencies in descending order (5000–3000–1000, etc.) rather than moving up and down the frequency number scale.

Utilizing multiple frequency combinations during each treatment session allows for very individualized protocols and increases the probability of achieving maximum treatment responses.

and muscle relaxation, which are local effects, are also enhanced at this frequency. Dr. Pontinen's technique (see Figure 2) is intended to maximize treatment response in the same visit by palpating the treatment area for pain sensitivity between successive laser applications.

1000 Hz. has been widely used for painful conditions of the skin and subcutaneous tissues. Accelerating wound healing would be a prime example. This would be another example of a local effect.

### 50 Hz Frequency

This frequency has been shown to produce an anti-inflammatory and analgesic effect.<sup>13</sup> The anti-inflammatory effect is primarily a systemic effect. Subcutaneous tissues, fascia, tendons and small joints can also be treated using this frequency. The treatment of these structures would be a local tissue response.

### 5 Hz Frequency

This frequency provides the deepest penetration of any of the frequencies discussed here. It is at this frequency that the deeper tissue structures can be effectively treated. Such structures include facet joints, acetabular joints, herniated discs, etc. and outcomes are primarily the result of local effects. Tissue regeneration, classified as a systemic effect, is also accelerated at 5 Hz.

### Discussion

Some GaAs therapeutic lasers have a setting that allows for variable or continuous oscillating frequencies. An example of this

would be continuous cycling between 5, 10, 100 and 1000Hz. This seems to capture some of the specific effects from each frequency such as, pain relief, anti-edema, and anti-inflammatory effects.<sup>14</sup>

While local (primary and secondary) tissue effects and systemic (tertiary) effects were mentioned above as if they were separate and distinct responses, these concepts were only presented in that fashion in order to simplify understanding. In vivo responses involve both local and systemic reactions simultaneously. An example would be the irradiation of a local tissue—such as a lateral epicondyle of the elbow. In order to stimulate local effects of tissue saturation—such as increased production of ATP—there is simultaneous photochemical changes in blood cells circulating through the elbow that will carry the message to every part of the body and initiate increased beta-endorphin production, as well as many other systemic responses.

When using a GaAs laser, the best treatment responses will occur by utilizing different frequencies during the same treatment session.<sup>15</sup> The number of frequencies used depends on the clinical presentation of the patient during a particular visit. In the case illustration at left, I will use the example of a patient presenting with a new ankle sprain / strain to illustrate this approach. ■

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