

## Analgesic Effects

### **Analgesic effect of He-Ne (632.8 nm) low-level laser therapy on acute inflammatory pain.**

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**OBJECTIVE:** The aim of this study was to evaluate the analgesic effect of the low level laser therapy (LLLT) with a He-Ne laser on acute inflammatory pain, verifying the contribution of the peripheral opioid receptors and the action of LLLT on the hyperalgesia produced by the release of hyperalgesic mediators of inflammation. **BACKGROUND DATA:** All analgesic drugs have undesired effects. Because of that, other therapies are being investigated for treatment of the inflammatory pain. Among those, LLLT seems to be very promising. **MATERIAL AND METHODS:** Male Wistar rats were used. Three complementary experiments were done. (1) The inflammatory reaction was induced by the injection of carrageenin into one of the hind paws. Pain threshold and volume increase of the edema were measured by a pressure gauge and plethysmography, respectively. (2) The involvement of peripheral opioid receptors on the analgesic effect of the laser was evaluated by simultaneous injection of carrageenin and naloxone into one hind paw. (3) Hyperalgesia was induced by injecting PGE2 for the study of the effect of the laser on the sensitization increase of nociceptors. A He-Ne laser (632.8 nm) of 2.5 J/cm<sup>2</sup> was used for irradiation. **RESULTS:** We found that He-Ne stimulation increased the pain threshold by a factor between 68% and 95% depending on the injected drug. We also observed a 54% reduction on the volume increase of the edema when it was irradiated. **CONCLUSION:** He-Ne LLLT inhibits the sensitization increase of nociceptors on the inflammatory process. The analgesic effect seems to involve hyperalgesic mediators instead of peripheral opioid receptors.

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### **Retrospective study of adjunctive diode laser therapy for pain attenuation in 662 patients: detailed analysis by questionnaire.**

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**OBJECTIVE:** The aim of this study was to assess the long-term effects of low-level laser therapy (LLLT) through a retrospective survey using questionnaires. **BACKGROUND DATA:** The use of LLLT for chronic pain attenuation has been reported in the international literature for over 20 years. **METHODS:** We used a series of diode laser systems in which the most effective wavelength was consistently found to be 830 nm with an output power in continuous-wave of 60 mW. Subjects were 1,087 patients treated

by LLLT at the Shiroto Clinic from April 1992 to August 1995. Questionnaires were sent to subjects in September and October 1996. RESULTS: The reply rate was 60.9%, comprising 662 questionnaires (265 males, 397 females, mean age of 53.4 years). The total efficacy rating (excellent plus good) immediately after LLLT was 46.8% in men and 47% in women. At the time of the survey, this rose to 73.3% in men and 76.8% in women, with positive effects also recorded on psychosomatic factors such as well-being, physical energy, general fatigue, mental vigor, and emotional stability. LLLT effects continued for 1-3 days. No statistically significant difference in efficacy was seen between males and females. LLLT as used in the study is therefore considered safe, effective, and side-effect-free, making it an ideal adjunctive therapeutic modality for intractable chronic and other pain. CONCLUSION: Infrared diode LLLT is therefore considered safe, effective, and side-effect-free, making it an ideal adjunctive therapeutic modality for intractable chronic pain.

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## **Lasers and Pain Treatment**

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### **Summary**

The clinical application of low incident power density laser radiation for the treatment of acute and chronic pain is now a well established procedure. This paper reviews the currently available English speaking literature and summarises a selection of serious scientific papers which report a beneficial effect following the treatment of a wide variety of acute and chronic syndromes whose main presenting symptom is pain.

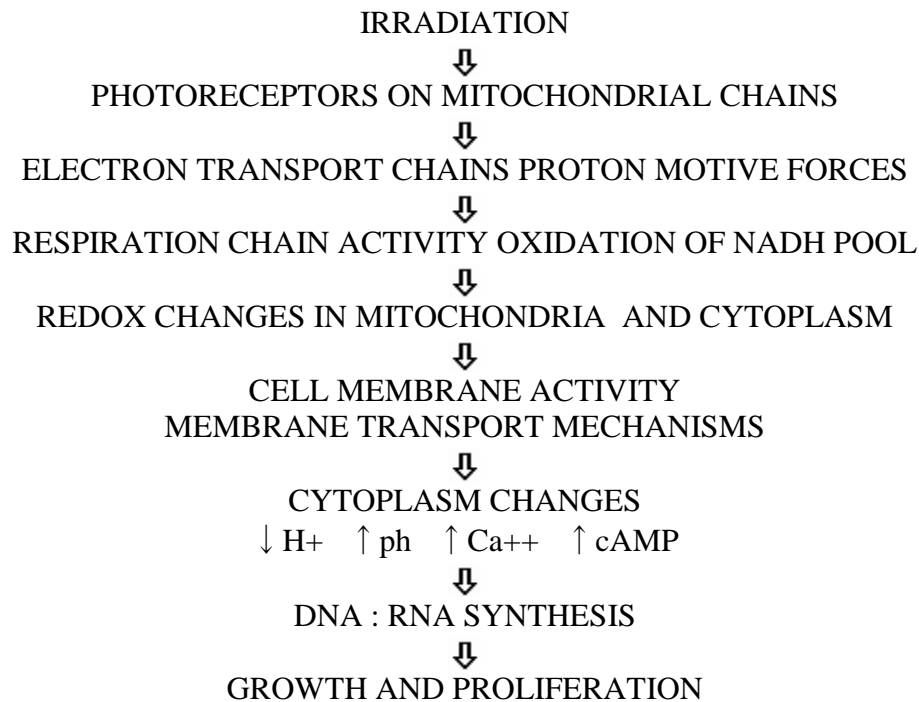
### **Introduction**

The Helium-Neon (He-Ne) laser at a wavelength of 632.8 nm has proved very successful in promoting wound healing particularly in indolent ulcers resistant to conventional methods of therapy. However, its limited depth of penetration and low power output have rendered it less effective when treating more deep seated causes of pain. The laser more frequently used for pain therapy is the Gallium Aluminium Arsenide (GaAlAs) diode emitting coherent light in the near infra-red waveband, usually 820 - 830 nm, and with a continuous wave power output of some 60 mW. The optoelectronic rationale for choosing these parameters has been discussed by Moore and Calderhead (1).

During the past 15 years experimental research has greatly added to our knowledge of the response of tissue radiation. Figure 1 summarises some 10 years work by Karu (2) into the cellular response to photon energy. Additional research at the Tissue Repair Research Unit at Guy's Hospital, London, has detailed the local tissue changes following exposure to laser light. The current concept is one of a dual response to laser bioactivation.

The immediate or primary effect is a local tissue response to direct irradiation and comprises vasodilatation with increased circulatory flow: enhanced lymphatic drainage; increased neutrophil, macrophage and fibroblast activity; and an improved metabolic function in depressed or damaged cells. The delayed or secondary response consists of a systemic effect caused by circulating photoproducts of irradiation in the blood and lymphatic systems. Increased plasma concentrations of certain types of prostaglandins, enkephalins and endorphins have all been identified and most probably play a major role in the mechanism of pain attenuation.

**Figure 1: Cellular response to laser irradiation**



### Acute pain therapy

Acute trauma is invariably associated with a degree of soft tissue injury comprising swelling, haematoma, pain, reduced mobility and in the lower limbs impaired weight bearing. Sporting injuries and domestic accidents usually involve damage to muscles, joint ligaments and tendons. Examples include a sprained ankle or wristed or a twisted knee. Most extensive soft tissue damage tends to result from industrial crush injuries or road traffic accidents. In the absence of bone fracture or other injury demanding priority treatment laser therapy should be instituted at the earliest opportunity. Kumar (3) reported a comparative study in 50 patients with inversion injuries of the ankle. He found that compared to conventional physiotherapy the laser treated patients showed a more rapid resolution of symptoms and an earlier return to full weight bearing. Patients were treated with a GaAlAs diode laser (830 nm: 60 mW) at 48 hour intervals on a maximum of 3 occasions. A similar therapeutic regime has been described for whiplash injuries of the cervical spine (4). Ben Hatit and Lammens (5) used a defocussed CO<sub>2</sub> laser to treat a

variety of acute musculoskeletal problems. The energy density varied between 40 - 70 J/cm<sup>2</sup>. Patients were treated twice a week for up to 10 sessions.

Beneficial effects of laser therapy in acute small joint inflammation in rheumatoid arthritis has been described by Asada et al (6). Multiple point irradiation using a GaAlAs diode (830 nm:60 mW) was applied for 15 seconds to each point. Pain was reduced by up to 66 % together with an improvement in the measured range of movement (ROM). In a similar report involving 938 patients with osteoarticular pain Soriano (7) found pain attenuation of 88 % when treating a variety of acute conditions such as tendosynovitis, lumbago and cervical pain. He used a GaAs diode (940 nm: pulsed 10,000 Hz: average power 40 mW) to treat patients twice weekly for a maximum of 10 sessions. The energy density delivered was 6 - 10 J/cm<sup>2</sup> per irradiated point.

Laser therapy also proved helpful in reducing the severity and duration of postoperative pain. In a comparative study involving 20 patients undergoing elective cholecystectomy Moore et al (8) reported a 50 % reduction in the postoperative pain experienced by the laser treated patients together with a concomitant reduction in analgesic requirements.

### **Chronic pain syndromes**

Chronic pain, as the name implies, may last for months or years. Pain may arise as a result of damage caused by trauma or surgery or be manifested as a symptom of a systemic disease process. In later life pain due to musculoskeletal "wear and tear" is very common. Finally neuralgic pain such as postherpetic or trigeminal neuralgia can cause prolonged problems to sufferers. A high percentage of patients referred for laser therapy will have already shown little or no response to conventional methods of treatment.

In rheumatoid arthritis (RA) laser therapy can benefit not only the pain of acute small joint inflammation but also the more established chronic pain of the disease. Gartner (9) in an excellent review article on rheumatology considered some 18 papers published over a 10 year period. All involved double blind trials of therapy with 5 having a cross-over element. In considering the effect of laser therapy in chronic rheumatoid and associated musculoskeletal conditions all but one of the reports noted a significant improvement in pain. In his own work Gartner used a 904 nm infra-red laser to treat a variety of tendinopathies with a better than 80 % success rate in relieving pain. He compared this to a similar rate of pain attenuation using anti-inflammatory drugs

(NSAIDs) but noted that whilst laser therapy was free of side effects some 20 % of patients treated with NSAIDs suffered unacceptable side effects of medication. Asada and his colleagues (10) in a further study of some 170 patients with rheumatoid arthritis used similar laser parameters and treatment protocols to their earlier reported work. The group achieved pain attenuation of up to 90 % and improvement in ROM of up to 56 %.

In a report of some 1000 treatments using a GaAlAs diode laser (830 nm: 60 mW) for a wide variety of chronic pain syndromes Moore (11) noted an overall reduction in pain levels of some 70 %. Trelles et al (12) used a similar diode laser to treat 40 patients with degenerative joint disease to the knee. They delivered 18 J/cm<sup>2</sup> to each of 4 points around

the knee twice a week for 8 weeks and reported a significant pain reduction in 82 % with improved joint mobility. Li (13) used a 25 mW combined CO<sup>2</sup>/HeNe laser to treat 90 patients with cervical spondylosis. Laser therapy was administered to a variety of acupuncture points for 10 minutes daily for 2 periods each of 10 days with an intervening rest period of 10 days. 90 % of patients showed symptoms improvement with an excellent result in 43 %.

Fender and Diffie (14) reported an interesting trial involving patients suffering from chronic generalized musculoskeletal pain. They irradiated the stellate ganglion using a HeNe laser with an initial exposure of 6 minutes (36 J/cm<sup>2</sup>) gradually increasing over 4 - 6 weeks to a maximum of 15 minutes (90 J/cm<sup>2</sup>). They postulated a mechanism of reduced sympathetic irritability causing a stabilisation of the response loop and a breaking of the pain cycle. In resistant cases they also treated segmental dermatomes and site specific trigger points.

Patients suffering from postherpetic neuralgia (PHN) have shown a good response to laser therapy. In a double blind cross-over trial Moore et al (15) reported a mean reduction in pain levels of 74 %. Patients were treated with a GaAlAs diode (830 nm: 60 mW) with the laser applied in contact mode to the centre of each 2 cm<sup>2</sup> grid over the affected area giving 24 - 30 J/cm<sup>2</sup> to each point. Treatment was given twice a week for 4 weeks. Using an identical treatment protocol but an extended regime of some 12 weeks Kemmotsu et al (16) reported at the end of treatment pain attenuation of 89 %. Otsuka and colleagues (17) used an 8.5 mW HeNe scanner to treat the acute rash of herpes zoster. Once the skin rash has subsided treatment was continued using a GaAlAs laser (830 nm: 60 mW). Within 1 month pain had been reduced by 76 % with a final end treatment improvement of 97 %. The early introduction of laser therapy produced a rapid resolution of acute herpes zoster rash and a reduced incidence of PHN.

## **Discussion**

Laser therapy is effective for a wide variety of acute and chronic pain syndromes. During the past 7 years the Laser Therapy Journal has featured some 30 papers on the subject. The preferred laser is the GaAlAs diode emitting light in the near infra-red usually at 830 nm. The majority of reports detail a power output of 60 mW continuous wave. Recently, however, researchers have been assessing the use of higher output powers in the range of 150 - 300 mW.

In a preliminary trial Yamada and Ogawa (18) compared the results of treating PHN with 60 and 150 mW. They found that the higher output power reduced both the frequency and duration of the treatment sessions and improved pain attenuation by some 25 %. Ohshiro (19) has devised an ingenious protocol for a computer controlled double blind comparative trial which compensates for the placebo effect of treatment and for patient and therapist bias. In a paper comparing the therapeutic outcomes in 2 geographically separate but otherwise identical clinics Shiroto (20) described how a positive therapist attitude motivated by enthusiasm and commitment can improve the results of therapy by 15 - 20 %.

There remains a need for more scientific studies based on well constructed double blind comparative trials. Nevertheless the bulk of published work to date supports the use of laser therapy for the treatment of pain. In a report of the cost-effective benefits of using laser therapy to treat PHN Moore (21) noted that, compared with conventional methods of treatment, laser proved to be not only more effective but more economical as well. The added advantage of absence of side effects, non-invasive nature of therapy and the ease of application ensured good patient acceptance of the treatment modality.

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### **Joint International Laser Conference in Edinburgh**

In September, 2003, the Edinburgh International Conference Centre in Scotland hosted the Joint International Laser Conference, organized jointly by the American Society for Laser Medicine and Surgery, European Laser Association and British Medical Laser Association. More than 500 registered participants had the opportunity of seeing not only the most advanced laser medical technology presented by 39 exhibitors, but also of attending numerous meetings and presentations, getting acquainted with top issues of laser surgery and therapy. A significant portion of scientific papers and posters dealt with laser therapy (LLLT), and theory was well supplemented with a series of educational courses called "How I do it". The organizers provided Laser Partner with full text of some of the lectures and now we bring the first one.

### **Low Level Laser-Therapy in pain treatment of the ambulatory system**

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#### **Zusammenfassung**

#### **Summary**

In spring 1995 we expanded our treatment methods with Low Level Laser Therapy. We decided to test the effectiveness of this kind of therapy through a study on 41 consecutive patients with ailments of the ambulatory system. For each case respective parameters, such as diagnosis, localisation, number of treatment points and output of the applied laser energy, were listed on a individual protocol where the patient also had to assess his pain

(before and after the treatment) to a number on the so called visual-analog pain scala (rating from 1 to 10). Furthermore the doctor had to note objective parameters like mobility, inflammation and swellings before and after the laser therapy. The indications concerned exclusively pain of the ambulatory system, especially epicondylitis and other posttraumatic or stress induced pain of tendons and articulations, but also some degenerative changes of joints (arthrosis of knee and shoulder).

During this study no other therapy method or drugs were applied, in order to allow a reliable judgement of the effectiveness of laser therapy. Conventional methods were only used if the treatment by laser light was not sufficiently effective.

Generally, the results obtained with laser therapy were very good - both subjectively and objectively rated. Only 12 percents of the patients felt no pain release, one patient had to stop the laser therapy after two applications because of an increasing subjective pain. 73 percent of the patients felt a good or very good effect of the therapy. The treated patients liked laser therapy very much, because there are no side effects, the treatment is painless and the ailment decreases rapidly.