

**Key words:** Lower back pain, Lumbalgia, laser therapy, lumbar osteoarthritis.

# Chronic lumbago due to osteoarthritis treated by low level laser therapy.

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## ABSTRACT

In cases of chronic Lumbago caused by osteoarthritis low level irradiation is a good alternative as physiotherapeutic treatment. PS we have observed clinically and objectively significantly efficacious results in 45 patients, men age 52; in a sample of 18 female and 12 male diagnosed with chronic lower back pain caused by osteoarthritis.

Eight treatment sessions were carried out, one session per week, with a Gallium Arsenide laser of 905 nm. The hand pieces of 16 diodes were used to irradiate 13 points in the lumbo-sacral region for 60 seconds each.

The laser treatment was significantly effective in resolving pain in 33 of the 45 patients. Treatment permits combination with Paracetamol at low dosages.

## INTRODUCTION

Chronic degenerative joint diseases and their symptoms, in a significant percentage of cases, can cause neurological complications, [1, 2], nervous system disorders and emotional imbalances [3], are often the cause of absence from work [4, 5].

Among the treatments against pain and inflammation which are characteristic of joint diseases [6], treatment with the low

power Gallium Arsenide (GaAs) diode laser is offered as an alternative to regular medication. [7, 8, 9].

As with osteoarthritis of any joint, the clinical manifestation of lumbar osteoarthritis presents with pain and limitation of movement. Obesity, abnormal posture, joint overuse, traumatic compensations, instability of bone support structures, etc... negatively impact its development.

Seibert, Brockhausen and King [10, 11, 12], in their studies, reported that using pulsed laser light at a power of 10 mW, obtained pain relief.

Irradiating laser light on painful areas would act as mediator in the analgesia of the joint. As communicated tolerance of pain and sensitivity expressed by patients improves significantly after half a minute of irradiation at an energy of 2 mJ. [13, 14]. Double-blind and placebo control studies have identified the analgesic effect of laser at low doses when irradiating during 30 seconds on trigger points, and referred pain in the wrist joint. According to Walker, effects of pain suppression mediated by the use of the laser would be a response of nerve endings to this particular kind of light. Nerve endings connected to the area of referred pain are photosensitive and capable of generating an action

potential in response to laser irradiation when appropriate doses and frequencies are used [15].

Low-power laser irradiation has been used to enhance the survival of surgical flaps and grafts, and to accelerate the process of wound healing, with no side effects being identified. The exact mechanism of cellular photo activation produced by the laser light is not yet entirely clear [16], however, numerous studies demonstrate in basic analyses in cell cultures and animal experiments, that there are grounds for clinical application, such as pain treatment [17].

Bjoldal observed in animal studies that with doses of 6 to 10 joules (of energy density), significant anti-inflammatory effects are obtained [18]. In our study we have used doses of 0.4912 J/cm<sup>2</sup> on each of the treatment points of the lower back where pain was, and have also obtained good results. Although the dose is significantly lower as energy density, the SAEF (Total Energy Deposited per Treatment) are similar. In our study the SAEF and the energy density are identical and this leads us to believe that the therapeutic window of analgesic effect with the laser is related to the point of application and also the total energy deposited.

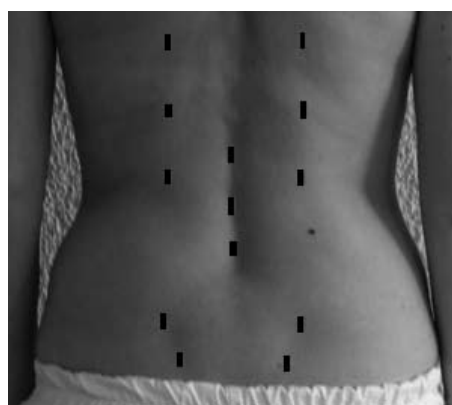
This study presents the use of the low power infrared laser (IR) in the treatment of lower back pain caused by osteoarthritis in 45 patients who received 8 treatment sessions. We objectively analyzed the evolution of pain and the improvement of general condition of patients, and also changes in the mobility of the lumbar spine.

## MATERIALS AND METHODS

### The laser system

Treatment was performed with an infrared (IR) Gallium Arsenide (GaAs), pulsed laser diode 905nm wavelength (*Lux 16, Medilight, SL Espulgues de Llobregat, Barcelona*). This system has a console which houses the power source, the hand-piece being pentagonal in shape and an

area of 10cm<sup>2</sup> housing the 16 diode laser, distributed equidistantly (Fig.1).



**Fig.1.** Points for the application of the laser, corresponding to the anatomical references of the lumbar and sacral-iliac area.

The peak power of pulsed emission from each of the diodes is 6 W. The total set of 16 laser diodes of the hand-piece that emit in unison is 96W peak power and 96mW. Mean power at a maximum pulse frequency of 5000 Hz and 200 ns laser pulse length. It is also possible to obtain a maximum average power of 314.572 nW, using the frequency of 16,384 Hz.

For treatment on each point, we selected the pulse frequency from among the various programs offered by device. Then, there are 15 possibilities of treatment in accordance with the pulse frequency used. In the present study, the pulse frequency used in each treatment was 4096 Hz per second, corresponding to program 13, which is equivalent to an average power of 4915 nW per diode, with total of 78.64 nW (16 diode laser).

During treatment, the aim was to cover the lumbar area, which was practically obtained by using a 10 cm<sup>2</sup> hand-piece with programme 13. The total energy per pulse each diode for a minute's irradiation corresponded to 0.2949 Joules/diode and for all 16 laser diodes was 4.7184 Joules. The dose, that is to say, the energy density or fluence corresponding to each treatment (10 cm<sup>2</sup>) was 0.4718 J/cm<sup>2</sup>.

### Patients and treatment sessions

We treated 45 patients of both sexes, 27

Pt.	Sex	Age	Arthritis
1	F	40	1
2	M	42	2
3	F	42	3
4	F	42	2
5	M	42	1
6	F	43	3
7	M	50	2
8	F	50	2
9	F	50	4
10	M	50	4
11	F	50	2
12	M	51	3
13	F	51	2
14	M	51	1
15	F	51	2

Pt.	Sex	Age	Arthritis
16	F	51	2
17	F	51	2
18	M	51	3
19	F	51	2
20	M	51	4
21	F	51	1
22	M	52	2
23	F	52	1
24	M	52	3
25	F	52	2
26	F	52	2
27	F	52	2
28	M	53	4
29	M	53	2
30	F	53	3

Pt.	Sex	Age	Arthritis
31	F	53	2
32	M	53	1
33	F	57	2
34	F	57	2
35	F	58	3
36	M	58	2
37	M	58	4
38	F	58	3
39	F	59	1
40	M	59	2
41	F	59	3
42	F	60	2
43	M	60	1
44	F	60	3
45	M	60	2

**Table I.** Control of the patients (sex, age and degree of osteoarthritis).

F=Female; M=Male // **Degree of osteoarthritis:** 1) Very important, 2) Important, 3) Moderate 4) Early stage of osteoarthritis

female and 18 male, aged between 40 and 60 years (means age 52 years). All patients suffered from chronic lower back pain due to osteoarthritis (Table I).

In the selection criteria we took into account that the patients had x-rays confirmed diagnosis of osteoarthritis, with manifestations of chronic lower back pain for more than four annual periods of exacerbation. Patients had to have employment outside their homes, excluding those who were on sick leave or were unemployed due to physical disability, as well patients with over 10 kg excess weight. Neither, insulin dependent diabetic patients or those suffering from degenerative systemic diseases and/or obvious psychopathology were accepted. All patients underwent analysis of blood and urine. Interviews and basic tests for screening of infections and neoplasm were conducted, as well as to rule out metabolic disorders and inflammatory rheumatic diseases. Neurological examination was also conducted to exclude from the study patients receiving treatment for diseases of the nervous systems.

To study the possible correlation between the degree of osteoarthritis, its clinical expression and its relationship with the development and favourable or unfavourable changes experienced with treatment, the arthritis was scored as **1)** Very Serious, when the patient was suffering constant pain, even at night turning in bed while sleeping; **2)** Serious, when pain was present during the day, but it was medium degree, allowing the patient to work, disappearing when at rest; **3)** Moderate, when pain appeared only due to effort, and **4)** Early Stage Osteoarthritis, when sometimes the patient experienced pain during overstraining which disappear with sleep.

With the aim of categorizing the symptoms suffered by patients and their characteristics, the Lattinen test was used, adapting it for this study. In the Table II, the intensity and frequency of pain and the degree of disability are shown. The patients informed as to the quality and hours of sleep and, likewise Paracetamol consumption through out the study period was documented. (Table II).

Arthritis	Arthritis	
INTENSITY OF PAIN	LIGHT	1
	IRRITATING	2
	INTENSE	3
	VERY INTENSE	4
FREQUENCY OF THE PAIN	OCCASIONALLY	1
	FREQUENT	2
	VERY FREQUENT	3
	CONSTANT	4
CONSUMPTION OF PARACETAMOL (FREQUENCY)	OCCASIONALLY	1
	REGULAR	2
	MANY TIMES	3
PHYSICAL DISABILITY	LIGHT	1
	MODERATE	2
HOURS OF SLEEP	NORMAL	1
	WAKE SOME TIME	2
	WAKE SEVERAL TIME	3

**Table II.** Assessment parameters associated with pain. (Adapted from Lattinen test):

All patients, before starting the laser sessions, had sometimes taken anti-inflammatory medications; however, they were only admitted to the study after suspending medications for 15 days. Pain intensity was rated as **1)** Slight, **2)** Bearable, **3)** Intense, **4)** Very intense (Table II) according to criteria determined in an Analogue Rating Scale. Patients were recommended not to take medication for treatment of arthritis, but could take Paracetamol 500 mg. up to maximum of 4 tablets per day if required. It was recommended to suspend any kind of physical treatment during the period of laser sessions. The patients were informed of the nature of the treatment sessions and agreed to respond to evaluations questionnaires.

All patients evaluated their degree of disability with the following classifications: **1)** Mild disability, and **2)** Moderate disability. No patient of the study used any form of aid to move or was totally disabled. (Table II)

### Method of treatment

The treatment applied during the 8 sessions, one per week, was laser irradiation with the patient in prone position, radiating on the 13 selected points, 6 points distributed bilaterally and equidistant along the Paravertebral muscles: 3 points on the spinous processes of the lumbar vertebrae L3, L4, and L5 and finally 2 points in each of the sacroiliac joints. Irradiation time on each point was 60 seconds. The area of treatment applied to each point was approximately 20 x 20 cm. Which corresponds to the dimensions of the window of the hand piece which contains the 16 laser diodes, thus during treatment practically the whole lumbo-sacral area was irradiated.

When applying, the window of the hand piece rests firmly on the specified points without applying pressure, or causing pain, and always keeping a good contact with the patient's skin.

At the end of the first treatment session, patients were recommended relative rest, avoiding straining the lumbar region. As of the second treatment session, it walking on level terrain was recommended, in comfortable shoes, warming patients that they should avoid any painful manifestation; the emergence of pain would serve as a warning to cease the activity that they were doing. Regarding food, they could continue eating as usual, but patients who exceeded the corresponding average weight, were advised a balanced diet of 1000 calories.

### Evaluation of results

The modified Lattinen test was completed in order to objectively assess the results of the evaluations that were conducted before starting treatment sessions, before the last sessions (eight month of treatment), and a month after finishing all treatment sessions. In these three cases, pain intensity and frequency of manifestation were assessed as were the intake of analgesics and the

degree of physical disability caused by back pain and monitoring of sleep quality in all patients. To identify the intensity of pain and mobility of the lumbar spine, the patient had to make active movements without straining. The movements were lateralisation, rotation to either side, bending and stretching, within the range of lumbar articular motion of each patient.

The efficacy of laser treatments was described by each of the patients, the physiotherapists who carried out the treatment and physician not involved in the study. The evaluation was performed before the eighth session and month later. Efficacy was as: 1) Very Good, 2) Good, 3) Fair, 4) As before, 5) Worse.

**1) Very good:** when the discomfort and symptoms disappeared

**2) Good:** when the patient had occasional discomfort, but he could carry out his normal tasks.

**3) Fair:** when the patient had occasional discomfort and needed to take Paracetamol.

**4) As before:** when the patient experienced no improvement and continued taking his usual medication.

**5) Worse:** when the subjective and objective symptoms of the patient, determined in the adapted Lattinen test and questionnaires, showed a worsening of symptoms, compared with their evaluations before starting treatment sessions.

### RESULTS

Only 3 patients did not participate in the last treatment assessment but was interviewed by telephone, confirming that had undergone and improvement with regard to pain and the mobility of the lumbar spine. The remaining patients completed the treatment sessions and assessments. It was noted that 30 patients improved significantly with the laser treatment (Table III), although it was difficult for 6 of them to gain clear

EFFECTIVENESS	PATIENT		PHYSIOTHERAPIST		DOCTOR	
	A	B	A	B	A	B
VERY GOOD	3	2	6	3	5	3
GOOD	31	28	34	31	33	31
REGULAR	8	12	2	8	4	8
EQUAL	3	3	3	3	3	3
WORSE	0	0	0	0	0	0

**Table III.** Effectiveness of treatment according to patient, doctor and physiotherapist.

**A:** Assessment of effectiveness before the 8th session of treatment

**B:** Assessment of effectiveness of one month after treatment sessions.

criteria on the results, because during the treatment sessions they had ingested, for periods of one or two days, 50 to 100 mg. of Diclofenac TM per day, in additions to the Paracetamol allowed. Of the remaining 15 patients, 5 said they had had a poor response to laser treatment and preferred the NSAID (Nonsteroidal anti-inflammatory drug) a medication, they usually used before starting the laser sessions.

### The Analogue Ratings Scale

In the analysis of pain showed significant improvement in 30 patients. The differences were most apparent during the course of treatment sessions, the intensity of pain significantly decreasing after the 3rd or 4th session (Table IV). Of the 30 patients who experienced a significant improvement, 27 were found to walk with greater ease, "not feeling the back" as they communicated. In the physical examination of the 27 patients, on whom it was possible to perform all tests and who responded to the questionnaires, it was noted that the range of lumbar joint mobilization had increased in all of them for both the rotation lateral bending, front bending and stretching; the improvement was greater in all these patients when comparing the values before starting treatment sessions with those of before the 8th session, that is, the last session. Of all the patients of the study, 5 reported having experienced increased pain intensity after the first treatments, which disappeared after 24 to 48 hours. Three of these 5 patients required to take

Paracetamol; however, the pain was not so severe as to prevent them continuing to work. Another 2 patients said they felt tired and held a sort of sedated feeling after each treatment session, especially after the first 2. All 30 patients who experienced an improvement with the laser sessions were able to perform their normal occupations (Table IV).

39 patients reported improved sleep quality (Table IV). Those who noticed pain when moving in bed while asleep stopped experiencing it. 23 patients commented they were in a better mood. (Table III, IV)

### DISCUSSION

Currently, there is enough basic experimental material which claims most of the therapeutic effects observed at clinical level.

Most lasers used in medicine base their effects on photothermal reactions, originated when reaching a practically specific temperature that leads to changes in the tissue of a reversible or irreversible nature. However, there is another kind of effects that occur locally and systemically due to low-power laser irradiation, without a significant increase in temperature in the irradiated tissue as a result of the diffusion of photons in tissue.

Arthritis	Arthritis		ASSESSMENT 1 <sup>a</sup> *	ASSESSMENT 2 <sup>a</sup> *	ASSESSMENT 3 <sup>a</sup> *
INTENSITY OF PAIN	LIGHT	1	10	40	36
	IRRITATING	2	18	3	9
	INTENSE	3	12	2	0
	VERY INTENSE	4	5	0	0
FREQUENCY OF THE PAIN	OCCASIONALLY	1	5	25	28
	FREQUENT	2	18	9	9
	VERY FREQUENT	3	13	6	3
	CONSTANT	4	9	5	5
CONSUMPTION OF PARACETAMOL (FREQUENCY)	OCCASIONALLY	1	11	39	37
	REGULAR	2	22	4	2
	MENY TIMES	3	12	2	6
PHYSICAL DISABILITY	LIGHT	1	21	40	40
	MODERATE	2	24	5	5
HOURS OF SLEEP	NORMAL	0	9	31	31
	WAKE SOME TIME	1	28	11	11
	WAKE SEVERAL TIME	2	8	3	3
<b>TOTAL</b>	<b>INDICATIVE O (INDEX) VALUE</b>		<b>422</b>	<b>284</b>	<b>255</b>

**Table IV.** Results (Adapted from Lattinen test):

\* Assessment 1th : Before the start of treatment sessions; Assessment 2nd: Before the 8th and final session; Assessment 3rd: One month after treatment sessions:



This laser photo-activation translates into a "photobiomodulating effects" that produce in turn anti-inflammatory and antialgic reaction. [19, 20, 21]

The analgesic effect of low power laser irradiation has been confirmed in studies reporting on photosensitivity in the irradiated areas, which would have consequences on the afferent conduction in thick diameter myelin fibres. It was observed that the speed of conduction increases during the laser irradiation. Under normal circumstances, the conduction of the thick sensory nerves have a slow conduction of the stimulus. These data suggest that laser irradiation with energies between 4 and 6 mJ, produce reactions in the forms of pain expression. Energies above those mentioned match the dosages of our study treatment. The studies showed that the analgesic reaction occurs when treatments are carried out with laser systems emitting in the infrared and this is due to the greater penetration into the skin of the infrared wavelength, and particularly that of 905 nm, with which the laser in our study operates. Infrared emission between 800-940nm corresponds to a window of deep absorption in the skin, which justifies the analgesic effect of the laser which would photoactivate nerve endings, with the result of pain relief [22]

Wu [23], indicates that pulse time between 50-150 ms would be best suited for the gradual decrease of the amplitude of the evoked response during laser treatment. Unlike the evoke that produce an electrical stimulus that remains unchanged, during laser treatment there is production of fatigue or habituation of the response of evoked potentials, even using small doses of laser energy.

The use of low power lasers for pain relief and inflammation caused by arthrosis is extensive [24, 25, 26, 27, 28]. Multiple studies find their effectiveness in medical indices, confirming such effectiveness in clinical practice.

The system of laser sessions used in our work corresponds to the frequency of sessions recommended for intensive

treatment of pain [28, 29]. In the treatment of epicondylitis, according to Stergioulas [30] and Vasseljen [31], the effects of pain relief are not obtained until after some 3 treatment, which coincides with what the patients in our study expressed. In our case, the effects were evident after the 4th week after the start of treatment.

In the therapeutic use of low power lasers for pain, there is little agreement among authors with regard to wavelength, laser power and energy used. The pulse repetition frequency, duration and recurrence of treatments tend to vary both in the guidelines recommended by the manufacturers and the experience provided by the clinician. Therefore it is difficult to compare the results of our study with the response observed in the studies in the literature using other laser systems [32, 33, 34, 35].

The results obtained by the patients of our study in the clinical evolution, the subjective manifestations of pain and the objective detection provided by the questionnaires, present the low-power laser as being effective and so this could be solidly be considered an alternative therapy against joint pain. [36].

Faced with lower back pain, experienced by a significant part of the population, any efficient alternative treatment must be taken into account, such as the proposed laser treatment in our study. According to the perception of treatment by patients, we can describe the laser treatment as a convenient and well-tolerated therapy. The laser treatment of pain is not an invasive method and its application is totally painless.

The results observed in the patients of our study suggest the possibility of combining laser treatments with painkillers and moderate exercise. Complementing laser treatment with exercises tailored to the possibilities of movement of the spinal column, taking into account the age and physical characteristics of the patient, are suitable in order to maintain, as far as possible, the elasticity of the vertebral joints [37]. Advantage could be taken

of the synergy of beneficial effects by the laser and mild analgesics that would palliate the pain of joint disease which is sometimes difficult to alleviate [38, 39]. The positive effects experienced by patients, can be described as significant, since 30 of the 45 who could not move without analgesic and/or anti-inflammatory medication, had managed to do so and experienced relief just with laser treatment sessions. 15 patients needed to take Paracetamol at some time during the study, without requiring other medications or time off work. This observation that the laser sessions in conjunction with Paracetamol intake can avoid a loss of work, suggests, as an alternative, the combinations of drugs and laser against chronic osteoarthritis. Paracetamol doses used for patients have a minimal yatrogenic effect and can be given for long periods.

The laser treatment was more effective in patients suffering from lower back pain of a shorter time of evolution. However, we believe that the individuality of the patient's character is a factor that has to be taken into account, as some patients are better disposed than others to improve. In our study we have taken into account the possible bias that might occur in the treatment of chronic pain in conjunction with the patient's psychosocial profile. Sometimes, chronic lumbar pain may be a manifestation of stress and/or may accompany situations of anxiety. In these cases, the pain needs prescription of myorelaxants and/or psychotropic drugs, however, in our study, these drugs are not recommended, to avoid the possibility of masking the true effectiveness of laser treatment.

Men experienced better and clearer effects than women, however, the differences were difficult to assess due to the small number of patients, so this observations can no be taken as an absolute factor. During the study it was no possible to identify factors that influence the placebo response to laser therapy. Patients experienced improvement after the session, enjoying

a better range of motion in joints and improving their quality of sleep. The approach of the study on a sample of patients for the most part not self-employed professionals, could bias the results because it is well known that the personal interest of a patient whose funds are based on their own work has every interest in recovering as quickly as possible to return to their activities [40]. However, in the sample of 45 patients of our study, only 3 were self-employed and precisely one of them was the one who did not report better results after laser treatment. This observation supports the effectiveness of treatment performed.

## CONCLUSIONS

This study suggests that low-power laser is effective in treating chronic lower back pain produced by osteoarthritis. The results of pain relief were significant, avoiding sick leave and taking painkillers and anti-inflammatory drugs in the case of most patients.

In the light of the results observed, we believe that the protocol used for the patients was effective in the treatment of chronic lower back pain, and that the laser sessions can be applied in combinations with Paracetamol pharmacotherapy.

## DECLARATION

The authors claim to have no interest in the laser system used in this study, nor any commercial relationship with the manufacturer. This study is registered in the memory of clinical follow-up activities of the Foundation Antonio Gimbernat 2007-2008, Cambrils (Tarragona).

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