THE ANALGESIC EFFECT OF 904 nm GALLIUM ARSENIDE SEMICONDUCTOR LOW LEVEL LASER THERAPY (LLLT) ON OSTEOARTICULAR PAIN: A REPORT ON 938 IRRADIATED PATIENTS

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In order to investigate the efficacy of LLLT with the gallium arsenide (GaAs) semiconductor laser in the therapy of acute and chronic osteoarticular pain, the author presents an analysis of 938 irradiated patients. The GaAs laser equipment used has a wavelength of 904 nm. The laser is pulsed, pulse width of 200 nsec, pulse frequency 10,000 Hz, a peak power of 20 W and an average power of 40 mW. The patients were treated five times a week on several points with doses of 6-10 J/cm² on each point in the painful area or areas. The efficacy of the laser treatment at the end of 10 sessions was evaluated using a colour scale with a four grade estimation: excellent, good, little or no effect and poor. Laser efficacy was arrived at by combining the excellent and good responses. The overall effectiveness was 74.73%, but considering acute pain it was elevated to 88.20%, and in chronic pain it was 69.27%. In some specific locations such as acute cervical pain, acute lumbar pain and tenosynovitis the major statistical effectiveness was achieved (100%, 88.46% and 84%, respectively). In chronic knee and hip pain the response was poor (38.23% and 35.71%, respectively). These results suggest that GaAs laser therapy at the parameters as reported is an effective, easy to apply and side effect free treatment for osteoarticular pain. From the reported data, the efficacy of 904 nm GaAs LLLT is greater in acute pain therapy compared with chronic pain types, and some anatomical areas tend to respond better to GaAs diode LLLT than others.

Key words: osteoarticular pain; GaAs laser; diode laser therapy; acute pain; chronic pain; anti-inflammatory effect

Introduction

Osteoarticular pain (OP) is a frequent cause of consultation by patients who present to the author's service. The incidence of OP is greater in patients older than 65 years old, where it represents the major proportion of outpatient consultation. The majority of these patients suffer from osteoarthritis and osteoporosis and they report repetitively chronic pain, which increased by trigger factors such as overexertion, trauma, exposure to cold and so on.

Stress and unnatural positions caused by particular work requirements cause paravertebral muscular contraction with alterations in the vertical axis of the spinal cord, resulting in pain. Painful articular inflammation can be provoked specially in the shoulder, knee and elbow joints. Trauma caused by participating in sports, such as sprains, fracture, haematomas and inflammation such as epicondylitis and tenosynovitis, are reported frequently as possible causes of OP.

It is clear and well defined that OP is a major symptom although many different aetiologies and pathologies are frequently encountered in daily medical

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Manuscript received: January, 1995
Accepted for publication: March, 1995

practice. Therefore, a correct diagnosis is required of the basic ailment in order to propose an adequate and effective treatment. Despite this, the majority of the situations the author has encountered have a common inflammatory process that causes pain. The resolution or improvement of the inflammation and its various mechanisms can usually resolve the case or at least attenuate the pain.

With the use of nonsteroidal anti-inflammatory drugs (NSAIDs) or corticosteroids, the pain can be well attenuated, or it may even disappear completely in approximately 60% to 80% of the cases.⁽¹⁻³⁾ However, important side effects are known and can be observed during the use of the above drugs.^(2,4,5) If it is additionally considered that the feeling of pain usually recurs in these patients, and specially in patients of advanced age, the over-frequent administration of these powerful drugs with their known and recognized adverse side effects must give the clinician cause for worry.

Some authors have reported that the use of low level laser therapy (LLLT) relieves OP in different groups of patients without side effects⁽⁶⁻⁹⁾. Thus, the possibility that with LLLT both an analgesic effect and an effective anti-inflammatory influence can be ob-

tained without the undesired effects of NSAIDs and corticosteroids appears as an interesting and even desirable alternative in the treatment of OP.

In the last years, the author and his colleagues have incorporated the use of LLLT to treat chronic and acute OP. This present study has set out to demonstrate retrospectively the results of the author's experience over a four year period.

Materials and Methods

The fields of clinical history of the patients were analyzed with the following criteria for admission to the patient population in the study.

- Patients with acute or chronic osteoarticular pain, treated with GaAs laser and with a completed follow up of 10 therapeutic sessions, were eligible.
- Clinical, radiological and laboratory diagnoses were mandatory that excluded with certainty infection, neoplasia, gout, Paget's disease and any of the collagen diseases.
- Patients undergoing treatment with corticosteroids, NSAIDs, masotherapy (massage) or rehabilitative physical therapy at the same time as the LLLT were

Fig 1: Graphical illustration of patient population broken down by pain type or site, showing total numbers, acute and chronic cases, respectively.

included in the trial, but the concomitant therapy was noted in the records.

The GaAs laser system used in the trial has a wavelength of 904 nm, and is a pulsed diode with a pulse width of 200 nsec, a pulse frequency of 10,000 Hz, a peak power of 20 W giving an average power of 40 mW.

The pain relief was evaluated by a trained interviewer before the first session and after the tenth session through an eleven-point colour scale in the following manner: difference of 0-3 points, little or no change; 3-6 points, average; 6-9 points, good; and 9-10 points, excellent. We calculated the overall efficacy of the laser treatment by combining the good and excellent scores, thus hoping to decrease possible skewing of the data by including the 'average' scores, most often associated with the placebo effect.

Five sessions were given a week, one session on each treatment day to a total of ten sessions (two weeks). The contact pressure method was used on selected points in the area of pain with the individual points separated by 2 to 4 cm. The doses were 6 J/cm² in acute pain and 8 J/cm² to 10 J/cm² in chronic pain.

We defined pain as chronic when it had a history of over three weeks or it had recurred two or more times in a year.

In the period of study 1,297 patients with OP were treated with GaAs LLLT. 359 patients that did not meet the criteria of admission were eliminated, the balance of 938 patients formed the trial population and were analyzed. Figure 1 illustrates graphically the population broken down by pain entities and separating acute and chronic cases. The age of the patients ranged from 16 to 79 years with an average age of 54.3 years. Females predominated slightly with a male to female ratio of 1:1.4 (389 male, 557 female). At the time of laser therapy 135 patients were taking oral nonsteroidal anti-inflammatory drugs (NSAIDs) and 177 patients were receiving massage or physical therapy.

Results

Table 1 summarizes the results obtained broken down by pain type or site, separating the acute from the chronic pain, arranged in order by the number of patients. The results are summarized as little or no im-

Table 1: Efficacy of pain attenuation broken down by site and by acute and chronic pain types. (Little or no improvement = $\pm$; average = +; good = ++; excellent = +++).

Pain Type or Site	Patient Numbers	Results				Overall Efficacy (%)
		($\pm$)	(+)	(++)	(+++)	
Cervical pain	290	15	22	81	172	87.24
Acute	75	—	—	15	60	100.00
Chronic	215	15	22	66	112	82.79
Lumbar pain	178	22	33	47	76	69.10
Acute	52	2	4	18	28	88.46
Chronic	126	20	29	29	48	61.11
Shoulder pain	121	19	17	37	48	70.24
Acute	12	1	2	3	6	75.00
Chronic	109	18	14	34	42	69.72
Knee pain	79	18	27	18	16	43.03
Acute	11	2	1	2	6	72.72
Chronic	68	16	26	16	10	38.23
Tenosynovitis pain	75	5	7	18	45	84.00
Acute	75	5	7	18	45	84.00
Chronic	—	—	—	—	—	—
Dorsal pain	70	10	12	26	22	68.57
Acute	3	—	—	1	2	100.00
Chronic	67	10	12	25	20	67.16
Heel pain	47	3	6	11	27	80.85
Acute	7	1	1	3	2	71.42
Chronic	40	2	5	8	25	82.50
Sacroiliac pain	28	2	4	11	11	78.57
Acute	2	—	1	1	—	50.00
Chronic	26	2	3	10	11	80.76
Hip pain	14	7	2	3	2	35.71
Acute	—	—	—	—	—	—
Chronic	14	7	2	3	2	35.71
Elbow pain	11	—	1	2	8	90.90
Acute	11	—	1	2	8	90.90
Chronic	—	—	—	—	—	—

Table 2: Data summarizing efficacy results for the total population, acute pain types and chronic pain types, respectively.
(Little or no improvement = $\pm$; average = +; good = ++; excellent = +++).

Item	Patient Numbers	Results			
		($\pm$)	(+)	(++)	(+++)
All Population	938	103	134	262	439
As percentage	—	10.98%	14.29%	27.93%	46.8%
Overall Efficacy (good + excellent) = 74.73%					
Acute Pain Patients	271	12	20	71	168
As percentage	—	4.42%	7.38%	26.2%	62.0%
Overall Efficacy = 88.2%					
Chronic Pain Patients	667	91	114	191	271
As percentage	—	13.64%	17.09%	28.64%	40.63%
Overall efficacy = 69.27%					

provement ($\pm$), average (+), good (++) and excellent (+++). Cervical, lumbar and shoulder pain accounted for over 60% of the total pain types. GaAs diode LLLT appeared to be most effective overall in elbow, cervical, tenosynovitis, heel sacroiliac and shoulder pain (all over 70% efficacy), although some variations were seen between the acute and chronic grades of each pain type.

Table 2 summarizes the data on overall efficacy rates for the total population, with separate figures for acute and chronic pain types. The overall efficacy rate for the total population was 74.73%. This ties in well with efficacy scores in other uncontrolled trials with large populations such as those published by Shiroto *et al.*⁽⁶⁾ Acute pain types accounted for 29% of the total population, and had an overall efficacy rate of 88.2%. Chronic pain types, on the other hand, accounted for 71% of the total population, and had an efficacy rate of 69.27% after the ten treatment sessions demanded by the protocol in the present study. These patients might

well benefit from an increased number of sessions. Figure 2 illustrates the above information graphically.

Table 3 shows a comparison of the response in patients with concomitant use of oral nonsteroidal anti-inflammatory drugs (14.4% of population) and LLLT, massage and/or physical therapy (18.9% of population) and LLLT, compared with patients who were treated with only LLLT (66.7% of population). There was no statistically significant difference in the efficacy rates of LLLT + NSAIDs (70.37%), LLLT + massage and/or physical therapy (76.83%) and LLLT on its own (75.08%). These efficacy rates are for the overall efficacy without being broken down into acute or chronic pain types.

Discussion

In the last decade, many different papers have been published on laser or light irradiation of cells, tissue

Fig 2: Overall efficacy rates for total population, acute and chronic cases, respectively.

Table 3: Comparison of 904 nm GaAs LLLT as an adjunctive therapy with concomitant NSAIDs, massage and physiotherapy compared with LLLT only.
(Little or no improvement = $\pm$; average = +; good = ++; excellent = +++).

Item	Patient Numbers	Results				Overall Efficacy (%)
		($\pm$)	(+)	(++)	(+++)	
Patients using NSAIDs + LLLT	135	23	17	34	61	—
As percentage	—	17.04	12.59	25.19	45.18	70.37
Massage/Physio. + LLLT	177	19	22	53	83	—
As percentage	—	10.74	12.43	29.94	46.89	76.83
LLLT only	626	61	95	175	295	—
As percentage	—	9.74	15.18	27.96	47.12	75.08

cultures and laboratory animal models that propose logical mechanisms and pathways of LLLT action in the control of the inflammatory, tissue repair and pain mediation processes.⁽¹⁰⁻¹⁴⁾ In the same way, double blinded clinical studies that set out to separate the placebo effect from the real therapeutic efficiency have been reported.⁽¹⁵⁻¹⁶⁾ It must however be admitted that a clear and definite scientific answer does not yet exist to explain all the mechanisms and pathways of LLLT in pain attenuation and the many other therapeutic applications which have been reported in the literature. The experience that the author presents is only a retrospective clinical observation. Even though it was done without control, randomization or double blind element, the author believes it is useful to point out some facts and encourage the readers (and researchers) to ask themselves some questions.

The author's data show an overall efficacy rate in pain relief of 75% in osteoarticular pain. This is similar to the responses that can be obtained with the use of NSAIDs;⁽¹⁻²⁾ however, attention must be focused on three great advantages in favour of LLLT: the ease and noninvasive aspect of its application; the lack of side effects; and the possibility of a better response in acute pain than in chronic pain. The data could be interpreted to conclude that, in order to alleviate a chronic pain condition, more than the 10 protocolized sessions in the present study are required. On the other hand chronic pain is usually associated with an underlying disease or condition of difficult resolution such as arthrosis. We must also ask ourselves the important question: to what extent is acute pain self limited and how much do we better its evolution with laser irradiation? Another apparent fact which emerged from the present study is the better response in particular anatomical sites such as the cervical, dorsal and heel regions, and knee and hip tendons. Interestingly, the use of nonsteroidal anti-inflammatory drugs and massage concomitant with

LLLT in our study did not reveal any significant differences in the final results when the different groups were compared according to the patients' evaluation response (Table 3).

Conclusions

In conclusion the author would like to make the following points.

- 1: GaAs diode LLLT seems to be effective in the relief of chronic and acute osteoarticular pain.
- 2: The efficacy is more significant in acute pain.
- 3: Some anatomical regions seem to have a better response to LLLT than others.
- 4: The lack of undesirable side effects, the economic accessibility to the method, the noninvasive and easy application and the good acceptance by the patients advances LLLT as a possible leading methodology for the relief of osteoarticular pain.
- 5: In the future, randomized and double blind studies must be designed with rigid protocols that analyze the different localizations of osteoarticular pain and separate acute from chronic pain in order to confirm the results of this uncontrolled retrospective study.

Acknowledgements

The author wishes to express his gratitude to Valentina Mlikota, Veronica Paoloni and German Nosarchuk for their invaluable help in the preparation of this manuscript.

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