

Nd:YAG laser in the management of low back pain.

A. Vervainioti

MSc. Physical therapist of “ARCOS” medical rehabilitation, 220 Mesogeion ave. zip: 15 561, Cholargos – Attica, Greece.

ABSTRACT

It is well established that low back pain is a common musculoskeletal disorder in adult population and has high social-economic impact. Among therapeutic methods we chose to test those suggested by international literature as effective, such as high intensity laser therapy, versus standard physiotherapy protocol (ultrasound, T.E.N.S., massage, mobilization and exercises). We designed a trial with three therapy groups. The main objective was to compare the efficacy of a specific Nd:YAG laser (HILT) with a standard physiotherapy protocol on low back pain and a combination of the two methods. It was within the scope of this paper to address in detail the variation of pain through pain type and localization for low back pain patients. Analyses showed that a significant number of patients with acute pain gained full recovery (28,8%), while patients affected by chronic pain obtained a significant improvement (31,1%) of pain symptoms, but not healing. Focal pain was healed more effectively than widespread pain. Final assessment showed that standardized physiotherapy (group A) did not manage to bring full recovery to patients, but just improving. Hilterapia® (group C) had better results in comparison with the standardized physiotherapeutic approach and showed early analgesic effects. Patients treated with both HILT and standardized physiotherapy showed

the higher clinical-functional improvement (group B), when compared with the other groups of patients. The results showed that a therapeutical protocol based on the combination of HILT and standardized physiotherapy may be successfully used to obtain improvement of pain symptoms and early healing in patients with non-specific pain of the lumbar area.

INTRODUCTION

Low back pain is a widespread musculoskeletal disorder in adult population and therefore has high social-economic impact.

Most of the patients are experiencing symptoms every year and 50-80% of general population will experience at least once in their lifetime affecting their quality of life [1]. It is the most common cause of functional disability among employees [2]. The past 15 years have seen an intensive research effort to identify effective treatments and management strategies for low-back pain [3].

Non-specific low back pain is a painful and self-limiting condition. Apart from severe pathology cases, current guidelines recommend pain management interventions plus reassurance and advice to stay active [4]. The aim of conservative treatments is usually to relieve pain and reduce associated disability. Several treatment options are recommended,

but there is sound evidence for only a minority of them [3,5].

Physiotherapy approach uses analgesia and anti-inflammatory effects to reduce pain symptoms.

Methods such as ultrasound, T.E.N.S., massage, mobilization and exercises, yielded mixed results [6,7]. Among physiotherapeutic modalities, there is little evidence to support the therapeutic effectiveness of ultrasound and T.E.N.S. in low back pain [8,9]. The total effect of these modalities on duration of the symptoms and among the different types of pain, vary and is quite limited [10,11]. Recent bibliography suggested that physical therapy has not provided stable results due to variability of the causes of low back pain and different modalities in the application of therapies [8,12,13]. Many studies have shown physiotherapy to be effective in improving the symptoms, proposing physiotherapeutic treatments as an acceptable physical modality for trigger points or muscle spasms [13].

Several studies reported the effectiveness of laser therapy in the treatment of low back pain, especially combined with exercises [14,15]. High intensity laser therapy (HILT) may be beneficial for pain relief and improved disability in patients with acute or chronic symptoms [16]. The wavelength (1064 nm), high intensity (up to 15,000 W/cm²) and high energetic impact characteristic of HILT, can effectively cure even the deepest chronic lesions [17]. It is well known that the variety of interaction mechanisms has positive effects and may occur when applying laser light to biological tissue for repair and pain management [18-20]. Laser radiation alters cellular functions involved in tissue repair. The photothermal processes produce tissue heating that reduces muscular spasm and supports relaxation, therefore with a general analgesic and sedative effect against pain.

For our study, among therapeutical methods commonly used, we chose to

test those suggested by international literature as effective, such as laser therapy, versus ultrasound, T.E.N.S., massage, mobilization and exercises. The main objective in this article is to compare the efficacy Nd:YAG laser (HILT) with a standard physiotherapy protocol on low back pain and also evaluate combination of the two methods. It is within the scope of this paper to address in detail the variation of pain through pain type and localization for low back pain patients.

METHODS

Participants & procedure

The recruitment and therapies took place in ARCOS, a private practice of medical rehabilitation in Athens, from October 2012 to January 2013. All patients had been recently diagnosed with non-specific low back pain. We made classification according to localization of the pain in focal and diffuse, and for the type of the pain in acute and chronic. All patients attended clinical practice and were asked to participate the study. After a detailed briefing, a written consent was asked to confirm their participation. The recruited patients aged 18 to 70 years and had Greek ethnicity.

Exclusion criteria concerned patients diagnosed with tumor or any neoplastic disease, use of NSAID's or heavy analgesic treatment, patients with psychiatric history, recent surgical procedure in the lumbar area, dermatoses or tattoo marks in the same area.

Forty-five patients (25 woman and 20 man) suffering with non-specific low back pain were recruited for the study. Participants were randomized into 3 groups: Group A) physiotherapy (n=15), Group B) Hilterapia® and physiotherapy (n=15), Group C) Hilterapia® (n=15). The 10-sessions treatment protocol lasted four weeks. The therapy sessions for each group included: Group A: 10 physiotherapy sessions. Group B: 10 laser

treatments +10 physiotherapy sessions. Group C: 10 laser treatments.

Randomization and blinding

The patients during their first visit for physiotherapy were randomly assigned to therapy groups A, B or C, using random numbers generated by an online generator (www.randomizer.org), which is based on a computer algorithm. Randomization, baseline and final assessments were not blinded.

Protocols and measures

Each group was provided with verbal and written information concerning physiotherapy assessment and laser effects. The 10-sessions protocol was completed for each patient in 4 weeks. Sessions were administered as follows: 3 treatments/week for the first two weeks and 2 treatments/week for the following two weeks.

Visual Analogue Scale (VAS) is a pain score with scale 0-10, which was used to evaluate the subjective pain symptomatology before each application. Furthermore, after the 10-session protocol each patient received a total physiotherapy assessment and the level of recovery was evaluated in a 4-point scale (cure, improve, unchanged, worse).

The physiotherapy assessment included a standard protocol with ultrasound application, electrotherapy through T.E.N.S., massage, active and passive mobilization and exercises, all specific for the lumbar area [21]. Physiotherapy treatment lasted 60-90 min and modifications were performed only in mobilization and exercises section according to patients needs.

The laser applications were performed with Hilterapia®. The source was a pulsed Nd:YAG laser Hiro 3.0 device (ASA s.r.l., Vicenza, Italy), with the standard handpiece for pain therapy, which was oriented vertically to the surface of the patient's body. The treatment lasted 30 minutes. The preferred protocol

was chosen by a physiotherapist who is experienced in using the device (Table I).

The protocol included three phases (initial, intermediate, final). The initial phase, divided into three sub-phases and considered as a "cold" treatment, requires fast scanning and helps activate muscular relaxation and analgesia. The intermediate phase, which is static and purely analgesic, is divided into four sub-phases and carried out on the trigger points or pain points. The final phase, which is also divided into three steps and carried out with slow scanning, creates a slight local hyperaemia. In this manner, wash out of catabolites is activated and the antalgic effects, muscular relaxation and the articular range obtained during the previous phases improve. When necessary, according to the painful symptoms of each patient, modifications on the Hilterapia® protocol were done by shortening the intermediate phase.

Phase	Subphase	Fluence (mJ/cm ²)	Frequency (Hz)	Mode	Total energy (J)
Initial	Step 1	710	11	Fast	500
	Step 2	970	9	Fast	500
	Step 3	1070	4	Fast	500
Intermediate	Step 1	710	4	Static	(Depended on the number of treating points)
	Step 2	970	4		(Depended on the number of treating points)
	Step 3	1070	3		(Depended on the number of treating points)
	Step 4	710	5		(Depended on the number of treating points)
Final	Step 1	710	11	Slow	500
	Step 2	970	9	Slow	500
	Step 3	1070	4	Slow	500

Table I: Treatment protocol for Hilitierapia.

Characteristics	Percentage (%)	Group A (n)	Group B (n)	Group C (n)
Age (mean ± SD)	47,07 ± 14,11			
17-32	6 (13,3)	2	2	2
33-47	19 (42,2)	5	9	5
48-62	12 (26,6)	5	3	4
63-77	8 (17,7)	3	1	4
Sex				
Woman (n[%])	25 (55,6)	10	9	6
Man (n[%])	20 (43,5)	5	6	9
Cause				
Acute (n[%])	22 (47,8)	4	9	9
Chronic (n[%])	23 (51,1)	11	6	6
Location				
Diffuse (n[%])	20 (43,5)	5	11	9
Focal (n[%])	25 (55,6)	10	4	6

Table II: Baseline characteristics of the 45 participants.

Statistical methods

Group characteristics were presented as means, SD and percentage values. The mean values \pm SD were used as outcomes. The statistical calculations were performed using the SPSS for Windows (version 20) statistical software (SPSS Inc., Chicago IL).

Results

Among the 45 participants, 5 did not complete the 10-sessions protocol, three because of pain worsening and two due to early recovery. The mean age was 47,07 years, with the 42,2% being in between 33-47 and the highest percentage were women (55,6%). Often pain location was focal (55,6%) and cause of pain 51,1% was chronic (Table II).

By analysis of results according to the type of pain, we observed that more than half of the patients with acute pain gained full recovery (28,8%) in contrast to chronic pain patients, who had generally an improvement (31,1%) in pain symptoms (Table III). As regards pain location, the final results showed that

focal pain was healed more effectively than widespread pain (Table IV).

In each treatment session, the Mean VAS scores of patients were evaluated for each group (A, B and C). As shown in Figure 1, at the beginning all groups ranged

into the same pain levels. On 4th session, group B (Hilterapia[®] and physiotherapy) showed signs of early improvement, which continued over the next sessions. The final assessment showed minimum pain level with VAS 2,64 for group B, VAS 3,57 and 4,33 for group C and A, respectively.

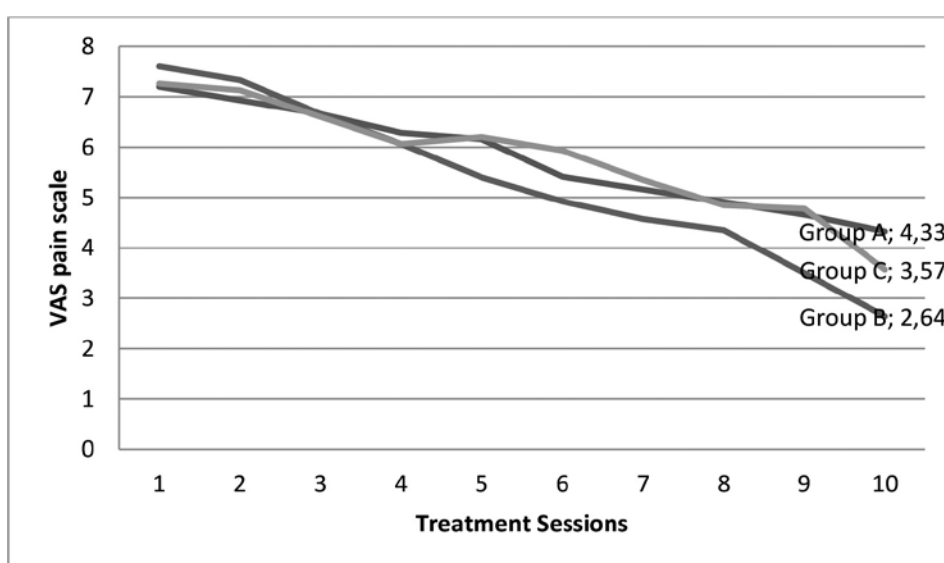


Figure 1: Pain levels through sessions per therapy groups

		Assessment				Total n
		Full recovery	Improve	Unchange	Worse	
Pain Type	Acute	13 (28,8%)	9 (20%)	0 (0%)	0 (0%)	22 (48,8%)
	Chronic	0 (0%)	14 (31,1%)	6 (13,3%)	3 (6,6%)	23 (51,1%)
Total n		13 (28,8%)	23 (51,1%)	6 (13,3%)	3 (6,6%)	45 (100%)

Table III: Crosstab of final assessment and pain type [n(%)].

		Assessment				Total n
		Full recovery	Improve	Unchange	Worse	
Localization	Focal	11 (24,4%)	13 (28,8%)	0 (0%)	1 (2,2%)	25 (55,5%)
	Diffuse	2 (4,4%)	10 (22,2%)	6 (13,3%)	2 (4,4%)	20 (44,4%)
Total n		13 (28,8%)	23 (51,1%)	6 (13,3%)	3 (6,6%)	45 (100%)

Table IV: Crosstab of final assessment and pain localization [n(%)].

		Assessment				Total n
		Full recovery	Improve	Unchange	Worse	
Therapy groups	Physiotherapy	0 (0%)	12 (26,6%)	2 (4,4%)	1 (2,2%)	15
	Hilterapia® & physiotherapy	8 (17,7)	6 (13,3%)	0 (0%)	1 (2,2%)	15
	Hilterapia®	5 (11,1%)	5 (11,1%)	4 (8,8%)	1 (2,2%)	15
Total n		13 (28,8%)	23 (51,1%)	6 (13,3%)	3 (6,6%)	45

Table V: Final assessment through therapy groups [n(%)].

Finally physiotherapy assessment per therapy groups (table V) showed that physiotherapy (group A) failed to provide full recovery to patients, but led to an improvement. Hilterapia® (group C) had better results, but some patients did not show significant changes of the symptomatology. The combination of Hilterapia® with the standard physiotherapy protocol was the most effective therapeutic approach in relieving low back pain.

DISCUSSION

This study was designed to evaluate the effectiveness of HILT against and within standard physiotherapy treatment in non-specific low back pain. It has been reported by other authors that HILT is effective in reducing low back pain [15,22,23]. In our study, the patients treated with Hilterapia® showed an improvement that persisted over time and, on average, was higher than the result observed in patients treated with standard physiotherapy protocol. Pain levels strongly and significantly decreased in patients exposed to a combination of HILT and standard physiotherapy protocol. The linear regression chart revealed that this combined treatment appeared the most effective therapy up from early sessions. Patients with focal pain were treated more successfully than the ones

with widespread pain. We speculated that, being the duration of the treatment the same (30 min), laser radiation is more effective on a limited area because the energy delivered to the tissue is higher and photothermal effects increase. The increased articular and muscular recovery made it easier for the therapist to carry out the typical rehabilitation exercises and manual therapy. Therefore the application of HILT resulted a very useful tool for the management of acute pain, (such as that caused by sports injuries).

This study has some limitations:

- Low back pain is a disease characterized by complex symptomatology and many possible causes. Therefore categorization of symptoms in homogeneous groups, diagnosis and classification are difficult. In literature, many different systems of classification have been proposed on the basis of symptoms, involved structures, duration of the disease, etc. and there is no agreement on what is the best [24,25]. We chose to recruit patients according to symptoms and not by exact diagnosis.
- An estimated bias arises from the arbitrarily chosen number of sessions: 10 treatments.

CONCLUSION

Each group of patients showed an improvement of the clinical parameters, but the subjects treated with both therapies (standardized physiotherapy and lasertherapy) showed a more evident improvement. This therapeutic approach can be recommended as the most effective and mainly in acute and focal pain types. Moreover, on the basis of our findings, HILT resulted more effective in improving pain symptoms and promoting an earlier healing of disease than the only standardized physiotherapeutic approach, when applied at patients with non-specific pain of the lumbar area. Future studies should extend these findings using differentiation of lumbar disorders according to diagnosis, examining other similar therapeutical tools and using objective analytical techniques to evaluate the effectiveness of the treatments.

ACKNOWLEDGEMENTS

The author would like to thank the management of the private practice who supported and enhanced this trial.

REFERENCES

- Konstantinovi L, Devecerski G, Petroni I, Jovi S, Cutovi M, Cirovi D. (2006). Quality of life in patients with subacute

- low back pain treated with physiotherapy rehabilitation. *Medicinski Pregled*, 1, 35-9.
- 2 Waddell. (1994). *Epidemiology review*. Annex to CSAG report on back pain. London: HMSO.
 - 3 Nachemson AL, Jonsson E. (2000). *Neck and back pain. The scientific evidence of causes, diagnosis and treatment*. Philadelphia; London: Lippincott Williams & Wilkins.
 - 4 Waddell, G. (2004). *The back pain revolution*. Glasgow: Churchill & Livingstone.
 - 5 NHS CRD (Centre for reviews and dissemination). (2000). *Acute and chronic low back pain*. *Effective health care*, 6.
 - 6 Leysen P, Bonbeke K, Remmen R. (2013). *Osteopathic manual treatment and ultrasound therapy for chronic low back pain: an illustration of osteopathic semantic confusion*. *The journal of American Osteopathic association*, 113, 660-1.
 - 7 Ebadi S, Ansari NN, Naghdi S, Jalaei S, Sadat M, Bagheri H, Vantulder MW, Henschke N, Fallah E. (2012). *The effect of continuous ultrasound on chronic non-specific low back pain: a single blind placebo-controlled randomized trial*. *British Medical journal of musculoskeletal disorders*, 13, 192.
 - 8 Zati A, Cardillo I, Fortuna D, Bilotta TW. (2004). *Conservative treatment of low back pain caused by intervertebral disk displacement, comparison among Nd:YAG laser therapy, TENS and NSAIDs*. *Atti della Fondazione Giorgio Ronchi anno LIX*, (pp. 389-398).
 - 9 Zati A, Fortuna D, Valent A, Pilippi MV, Bilotta TW. (2004). *High intensity laser therapy (HILT) versus TENS and NSAID's in low back pain: clinical study*. *SPIE*, (pp. 277-283).
 - 10 Kumar S, Beaton K, Hughes T. (2013). *The effectiveness of massage therapy for the treatment of nonspecific low back pain: a systematic review of systematic reviews*. *International Journal of general medicine*, 4(6), 733-741.
 - 11 van Tulder MW, Koes B, Maimivaare A. (2006). *Outcome of non-invasive treatment modalities on back pain: an evidence based report*. *Eur Spine Journal*, 15(1), 64-81.
 - 12 Murphy S, Blake C, Power CK, Fullen BM. (2013). *Outcomes of a group education/exercise intervention in a population of patients with non-specific low back pain: a 3-year review*. *Irish Journal of medical science*.
 - 13 Chou R, Atlas SJ, Stanos SP, Rosenquist RT. (2009). *Nonsurgical interventional therapies for low back pain: a review of the evidence for an American Pain Society clinical practice guideline*. *Spine*, 34, 1078-93.
 - 14 Gur A, Karakoc M, Cevic R, Nas K, Sarac AJ, Karakoc M. (2003). *Efficacy of low power laser therapy and exercise on pain and functions in chronic low back pain*. *Lasers Sugr Med*, 32, 233-8.
 - 15 Djavid GE, Mehrdad R, Ghasemi M, Hasan-Zadeh H, Sotoodeh-Manesh A, Pouryaghoub G. (2007). *In chronic low back pain, low level laser therapy combined with exercise is more beneficial than exercise alone in the long term: a randomized trial*. *Australian Journal of Physiotherapy*, 53(3), 155-160.
 - 16 Fiore P, Panza F, Cassatella G, Russo A, Frisardi V, Solfrizzi V, Ranieri M, Di Teo L, Santamato A. (2011). *Short term effects of high intensity laser therapy versus ultrasound therapy in the treatment of low back pain: a randomized controlled trial*. *Eur Phys Rehabil Med*, 47, 367-73.
 - 17 Zhou Y, Abdi S. (2006). *Diagnosis and minimally invasive treatment of lumbar discogenic pain - a review of the literature*. *The clinical journal of pain*, 22(5), 468-81.
 - 18 Zati A, Desando G, Cavallo C, Buda R, Giannini S, Fortuna D, Facchini A, Grigolo B. (2012). *Treatment of human cartilage by means of Nd:YAG laser therapy*. *Journal of biological regulators and homeostatic agents*, 26(4), 701-11.
 - 19 Gale GD, Rothbart PJ, Li Y. (2006). *Infrared therapy for chronic low back pain: a randomized controlled trial*. *Pain research & management*, 11(3), 193-6.
 - 20 Fedele D, Fusi F. (2010). *Thermal effects of NIR laser radiation in biological tissue: a brief survey*. *Energy for Health*, 10-14.
 - 21 Koes BW, Tulder MV, Thomas S. (2006). *Diagnosis and treatment of low back pain*. *British medical journal*, 332, 1430-4.
 - 22 Conte PG, Santamato A, Fiore P, Popresto A, Mazzaracchio M. (2009). *Treatment of low back pain: back school versus Hilt therapy*. *Energy for health*, 3, 10-13.
 - 23 Basford JR, Sheffield CG, William SH. (1990). *Laser therapy: a randomized controlled trial of the effects of low-intensity Nd:YAG laser irradiation on musculoskeletal back pain*. *Archives of physical medicine and rehabilitation*, 80(6), 647-652.
 - 24 Jenkins H. (2002). *Classification of low back pain*. *ACO*, 10: 91-97.
 - 25 Manusov EG (2012). *Evaluation and diagnosis of low back pain*. *Prim. Care* 39(3), 471-9