EFFICACY OF LOW LEVEL LASER THERAPY FOR SYMPATHETIC REFLEX DYSTROPHY SYNDROME IN GERIATRIC PATIENTS

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Sympathetic reflex dystrophy (SRD) is a frequent occurrence in geriatric hemiplegic patients, but the pathogenic factors (involvement of the peripheral and/or central nervous systems) of the disease are not yet clearly defined and are still a matter of debate. Many different diseases may produce SRD; this may frequently occur in hemiplegic patients so that elderly people cannot undergo rehabilitative kinetic therapy after a stroke, due to osteoarticular pain and dystrophic diseases. The aim of the present work is to analyze the effect of laser therapy at different wavelengths and doses (i.e. HeNe and CO₂ laser at low and high energy densities), in order to identify the technical conditions yielding the maximum treatment effectiveness in the protocol of rehabilitation of hemiplegic patients suffering from SRD. The method adopted by our Institute to establish the clinical diagnosis of each patient is based on the creation of a card in which the personal data; clinical diagnosis; medical history; the physical therapist's evaluation; the radiologist's report; and the clinician's assessment are recorded. The treatment was carried out by sweeping the laser beam over the area of articulation of the shoulder (area size $\approx 10 \times 15$ cm) and on the hand (area size $\approx 10 \times 10$ cm). Since the physical parameters of laser therapy for the treatment of this disease in hemiplegic patients have not yet been established, our trial was performed either with defocused CO₂ laser or with the HeNe laser at a range of increasing doses (energy density) in order to identify the laser parameters yielding the maximum effectiveness for the treatment. Therapy was performed daily (5 treatments/week), either with the CO₂ laser (energy densities ranging from 137 to 290 J/cm²) or with the HeNe laser (energy densities ranging from 0.229 to 0.311 J/cm²). At the time of writing there are 140 patients who have completed the therapy regimen with completed record cards. The results are still preliminary, due to the as yet unbalanced numbers of patients admitted to the different treatments, but a statistically significant difference was observed in the effect of HeNe and CO₂ laser ($p < 0.026$). In addition, a significant difference was found between the effects of low and high doses of CO₂ laser ($p < 0.024$) and between the results of treatments based on low dose CO₂ laser and high dose HeNe laser ($p < 0.006$).

Key words: sympathetic reflex dystrophy, hemiplegia, defocused CO₂ laser, HeNe laser, LLLT

Introduction

Sympathetic reflex dystrophy (SRD) frequently occurs in geriatric hemiplegic patients, but the pathogenic factors (involvement of the peripheral and/or central

nervous systems) of the disease are not yet clearly defined and still a matter of debate. A number of different changes in the nervous system may be involved and, particularly, the sympathetic nervous system plays an important role in causing dystrophic diseases and

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osteoarticular pain in the shoulder, arm and hand, through sympathetic activation of mechanoreceptive nerve fibres. Moreover, many different diseases may produce SRD; SRD frequently occurs in hemiplegic patients, so that elderly people cannot undergo rehabilitative kinetic therapy after a stroke due to osteoarticular pain and dystrophic diseases.

It is well known that laser therapy may be useful in reducing osteoarticular pain due to degenerative and/or inflammatory diseases⁽¹⁻¹¹⁾ and Rochkind in particular has demonstrated that HeNe laser therapy after surgery may stimulate either peripheral nerves or the dorsal roots in the spinal processes.⁽¹²⁻¹⁹⁾ Therefore we filed a therapeutic protocol with our ethics committee for the rehabilitation of elderly hemiplegic patients suffering from SRD based on the efficacy of laser therapy performed before kinetic physical therapy, which otherwise were precluded by osteoarticular pain.

In a previous note we presented the preliminary results of our trial with laser therapy on hemiplegic patients suffering from SRD,⁽²⁰⁾ in which we considered the effect of CO₂ defocused laser at very low incident doses (i.e. energy density or radiant flux). The aim of the present work is to analyze the effect of laser therapy at different wavelengths and doses (i.e. HeNe and CO₂ laser at low and high-energy densities), in order to identify the laser parameters yielding the maximum treatment efficacy in the rehabilitation protocol of hemiplegic patients suffering from SRD.

Materials and Methods

Laser Systems

The laser apparatuses used for therapy in our trial were: a CO₂ laser system (Étoile), wavelength 10,600 nm in continuous wave and with output powers ranging from 2 to 25 W. In the present study we used an output power of 3.5 W; a HeNe laser system (Mectronic),

LASETH - THERAPY

NAME AND SURNAME

PROFESSION

PT. CARD N° DATE

SHOULDER ARTICULATION RATING

EXTENSION
50°

DATE	RIGHT	LEFT
INITIAL		
FINAL		
FOLLOW UP

ABDUCTION
180°
(supine hand)

DATE	RIGHT	LEFT
INITIAL		
FINAL		
FOLLOW UP

FLEXION
180°

DATE	RIGHT	LEFT
INITIAL		
FINAL		
FOLLOW UP		

SUBJECTIVE PAIN (visual analogic scale)

RIGHT LEFT

INITIAL

FINAL

FOLLOW UP

QUALITY

ache - pang - pulsating - burning
others

FREQUENCY : continuous - intermitten

DURATION : seconds - minutes - hours - day

PROVOKED PAIN:

0 = none 1 = pain 2 = pain + grimace 3 = pain + grimace + reaction

	R.	L.	R.	L.	R.	L.
PAIN UPON PRESSURE	I. () ()	F. () ()	P.U. () ()			
PAIN WITH ACTIVE MOVEMENTS	I. () ()	F. () ()	P.A. () ()			
PAIN WITH PASSIVE MOVEMENTS	I. () ()	F. () ()	P.P. () ()			

NOTES.....

Fig 1: First part of the patient record card showing pre- and postirradiation ROM values and pain evaluation.

wavelength 632.8 nm, continuous wave, at an output power of 4.5 mW, in a variable scanning mode ranging from 2.5 to 2.8 cm/sec.

Patients and Records

In order to verify the efficacy of low power laser therapy in rehabilitation, the best method would obviously be to monitor two groups of patients in a double blind trial. Due to the practical impossibility of obtaining two required homogeneous groups of patients for a correct statistic evaluation, we defined a set of parameters to

OBSERVATIONS

TUMEFACATION		R.: INITIAL (Y) (N)	FINAL: (Y) (N)	FOLLOW UP: (Y) (N)
		L.: INITIAL (Y) (N)	FINAL: (Y) (N)	FOLLOW UP: (Y) (N)
HEAT ON TOUCHING		R.: INITIAL (Y) (N)	FINAL: (Y) (N)	FOLLOW UP: (Y) (N)
		L.: INITIAL (Y) (N)	FINAL: (Y) (N)	FOLLOW UP: (Y) (N)
THERMOGRAPHIC RATING		(Y) (N)	ECHOGRAPHIC RATING (Y) (N)	
FUNCTIONALITY RATING: 1 = none 2 = modest 3 = severe limitation				
		INITIAL		FOLLOW UP
		R. L.	R. L.	R. L.
		() ()	() ()	() ()
ASSOCIATED PHYSIOKINESITHERAPY.....				
CONCOMITANT MEDICAL TREATMENT				
PREVIOUS PHYSICAL AND MEDICAL THERAPIES				
DATE OF THE BEGINNING OF THE PRESENT SYMPTOMATOLOGY				
FOLLOWING (trauma, stress, etc.)				
DATE OF THE NEXT ACUTE PHASE (IF ANY)				
PAIN PRESENT:		INITIAL		FINAL
1* at night		during sleep (Y) - (N)	(Y) - (N)	
		when awake (Y) - (N)	(Y) - (N)	
		upon awaking (Y) - (N)	(Y) - (N)	
2* during the day		constant at rest (Y) - (N)	(Y) - (N)	
		depending on movements (Y) - (N)	(Y) - (N)	
3* depending on changes in the climate		(Y) - (N)	(Y) - (N)	
4* others				
		R. L.	R. L.	R. L.
PHYSICIAN'S OPINION: none () () fair () () good () () excellent () ()				
PATIENT'S OPINION: none () () fair () () good () () excellent () ()				

Fig 2: Second part of the patient record card used in the authors' clinic, dealing with patient history work-up.

be recorded at the beginning and at the end of each treatment, to evaluate the actual improvements for each treated patient.

The method adopted by our Institute to establish the clinical diagnosis of each patient is based on a record card in which the personal data; clinical diagnosis; medical history; the physical therapist's evaluation; the radiologist's report; and the clinician's assessment were recorded.

A record card (Figures 1 & 2) was specifically designed for the study for patients suffering from diseases of the shoulder and for sympathetic dystrophy in hemiplegic patients, which was filled out each session from which the data were analyzed at the end of treatment. The card included the following: the intensity of pain, evaluated by means of a visual analogue scale (Huskisson's scale); passive range of movement (ROM) and, if present, active ROM, measured in grades and checked with a goniometer; the presence of oedema; the radiologist's report, with particular reference to x-ray standards, ultrasound, telethermography and, if required, C.T. examination; and the specific pathogenic problems.

Whenever laser therapy was prescribed, we developed an individual treatment programme, based on the clinical diagnosis and on the patient's conditions. In the case of the scanning technique, the area to be treated was outlined on the patient's skin with a marking pencil to include the area of the articular disease. The size of the area to be treated (in the scanning technique) was recorded on a special anatomical map which was used by the biotechnician to perform the treatment according to the programmed schedule. For each treatment programme the technician recorded the irradiation technique and the doses administered on the patient's record card.

At the completion of laser therapy, the patients were visited by a team of experts, as well as by the same specialist who had performed the visit at the beginning of the treatment course, and their clinical record cards were completed with evaluations by both physicians and patients with respect to the results of the therapy. The results observed were classified by means of a 5-grade semiquantitative scale (very good, good, fairly good, poor, and little or no change), according to an objective functional assessment by the physical therapist and from the patient's subjective evaluation.

Table 1: Evaluation of patient recovery by a points system awarded for each symptom and degree of improvement.

Symptom	Recovery Scale			
	Poor 0-5%	Fairly good 5-25%	Good 26-50%	Very good >50%
Pain	1	2	3	4
ROM	1	2	3	4
Oedema	1	2	2	2

ROM = range of movement

Treatment Techniques

The treatment was carried out by scanning the laser over the area of shoulder articulation ($\cong 10 \times 15$ cm) and on the hand ($\cong 10 \times 10$ cm). Since the physical parameters of laser therapy for the treatment of this disease in hemiplegic patients have not yet been established, our trial was performed either with defocused CO₂ laser or with HeNe laser at a range of increasing energy densities, keeping the output power constant, in order to identify the ideal parameters yielding the maximum effectiveness for the treatment. Therapy was performed daily (5 treatments/week), either with the CO₂ laser (energy density ranging from 137 to 290 J/cm²) or with the HeNe laser (energy density ranging from 0.229 to 0.311 J/cm²). When considering evaluation of the objective effect of treatment in hemiplegic patients suffering from SRD, the degree of clinical immobility of the patients and the presence of different symptoms in the shoulder and in hands, which may play separate or joint roles in the disease together with pain and reduced articular fitness in the shoulder accompanied by oedema in the hand, must be taken into account. We therefore classified the effects by means of a semiquantitative scale (presented in a previous

work),⁽²⁰⁾ in which any effect obtained regarding any single symptom (pain reduction, recovery of articular fitness, hand oedema) yields a separate contribution to the total efficacy score, according to the scale illustrated in Table 1:

Results

Our results are illustrated in Table 2 in which the number of patients with very good and good, fairly good, or poor-null results are indicated for each type of laser treatment used, and the energy density applied. Very good and good results were obtained in 7 patients (38.9%), fairly good results in 9 patients (50.0%) and poor results or little or no change results in 2 (11.1%) patients, out of 18 treated with HeNe laser at 0.311 J/cm². Very good and good effects were achieved in 5 patients (50.0%), fairly good results in 4 patients (40.0%) and poor or little or no effect in 1 (10.0%) out of 10 patients treated with HeNe at 0.229 J/cm².

Very good and good results were obtained in 18 patients (50.0%), fairly good results in 12 patients (33.3%) and little or no effect in 6 (16.7%) out of 36 patients treated with CO₂ laser at a high energy density of 425.4 J/cm². Very good and good results were obtained in 14 (63.6%), fairly good effects in 4 (18.2%) and little or no effect in 4 (18.2%) out of 22 patients treated with CO₂ laser at a medium energy density of 153 J/cm². Very good and good results were obtained in 42 patients (77.8%), fairly good effects in 8 (14.8%) patients, and little or no effect only in 4 (7.4%) out of 54 patients treated with CO₂ laser at the low energy density setting of 137 J/cm².

Table 2: Results shown for the efficacy of each laser. Overall efficacy was obtained by adding the 'very good' and 'fairly good' results.

HeNe Laser				
Dose (J/cm ²)	Results			
	Very good + Good	Fairly good	Little or no effect	No. of patients
0.311	7 (38.9%)	9 (50.0%)	2 (11.1%)	18
0.229	5 (50.0%)	4 (40.0%)	1 (10.0%)	10
CO ₂ Laser				
Dose (J/cm ²)	Results			
	Very good + Good	Fairly Good	Little or no effect	No. of patients
425.4	18 (50.0%)	12 (33.3%)	6 (16.7%)	36
153	14 (63.6%)	4 (18.2%)	4 (18.2%)	22
137	42 (77.8%)	8 (14.6%)	4 (7.4%)	54

Discussion

Sympathetic reflex dystrophy is associated with diffuse superficial and deep burning pain in an extremity associated with vasomotor disturbances, neural trophic changes, and limitation in ROM or total immobility of joints which may be the result of some local injury or a systemic condition such as hemiplegia, however the pathogenic factors of the disease have not as yet been defined.

Since many different changes in nervous system may be involved, and particularly the sympathetic nervous system may play a role through the activation of mechanoreceptive nervous fibres, it seemed useful to develop a treatment protocol based on low level laser therapy applying either HeNe or the defocused CO₂ lasers at different incident doses.

The results obtained in the present study demonstrate that the HeNe and defocused CO₂ laser have a different effect in the treatment of sympathetic dystrophy in hemiplegic patients, with the defocused CO₂ being significantly more effective than the HeNe laser. The biological effect of different wavelengths may depend on the interaction with different chromophores,⁽²⁴⁻²⁸⁾ but also having some relationship with the interaction with enzymes without specific chromophore groups, for example changes in the levels of ATPase activity.⁽²⁹⁻³¹⁾ However, in clinical laser therapy, the wavelength-specific physical absorption characteristics and other physical phenomena may also play a role in the effects of laser therapy.⁽³³⁻³⁵⁾

In fact, regarding the dose-effect relationships in laser therapy, the structural complexity and non-homogeneity of the skin must be considered. During laser therapy, various physical phenomena may occur in sequence in the different layers, starting from the upper vital epidermal layers and progressing to the subcutaneous tissue. Therefore, the radiation beam may be reflected or transmitted, scattered or absorbed, or most likely a combination of all of these, resulting in a possible decrease in the energy delivered to the target of interest.⁽³¹⁾ The dose-related effects due to the different energy densities delivered by the CO₂ and HeNe systems in our preliminary study may well play a role in the clinical effects of laser therapy: further ongoing investigations will probably allow us to analyze more accurately the importance of the different physical factors involved in the effects of clinical laser therapy.

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