Laser biostimulation of the patients suffering from multiple sclerosis in respect of biological influence of laser light

Cezary Peszyński-Drews[a], Andrzej Klimek[b], Marek Sopiński[a], Dominik Obrzejta[a]
[a] The Diagnostics and Laser Therapy Centre of the Technical University of Łódź
95-Łódź, ul. Wólczańska 215
[b] The Department of Neurology of Regional Specialist "Copernicus" Hospital in Łódź
93-513 Łódź, ul. Pabianicka 62

ABSTRACT

The authors discuss the results, obtained so far during three years' clinical examination, of laser therapy in the treatment of patients suffering from multiple sclerosis. They regard both the results of former laboratory experiments and so far discovered mechanisms of biological influence of laser light as an objective explanation of high effectiveness of laser therapy in the case of this so far incurable disease. They discuss wide range of biological mechanisms of laser therapy, examined so far on different levels (cell, tissue, organ), allowing the explanation of beneficial influence of laser light in pathogenetically different morbidities.

Keywords: laser biostimulation, laser therapy, multiple sclerosis

1. INTRODUCTION

1.1. Multiple sclerosis

Among numerous diseases of nervous system, multiple sclerosis is the one which arouses the greatest interest among neurologists and researchers, as indicated by the fact that at European neurological congresses, for many years, most papers are dedicated to this issue. The reason for this is the fact that pathogeny of this disease is not known, as well as the factor causing it and the ways it spreads, while its incidence all over the world continually increases at an alarming rate[3,10.11].

The main question is how to prevent and what methods of treatment to choose. The therapy applied so far does not result in a complete recovery, but only alleviates the effects of the relapse in the remitting form (as remitting form is most common) and sometimes slows down progression of the disease in its two forms: primarily and secondarily advancing [11].

Multiple sclerosis is a chronic disease of central nervous system, characterized by dispersed foci of demyelination, and clinically – multifocality of symptoms, with a tendency to abating and relapsing, but which, in the end, always leads to disability[3,10,11].

The cause of the disease is not known. Immunological mechanisms causing autoagression towards myelin sheaths in central nervous system are considered to be responsible for it [3,10,11]. It is now the second most common, after angiodystrophic diseases, disorder of the nervous system, and at the same time the most common neurological disease causing disability of young, adult people before 40 years of age. In Poland, it is also the second most common disorder of the nervous system, with incidence rate of 60/100 000 [3].

In total population of northern Europe, according to data reported by the International Team of Experts, the sick rate fluctuates between 25 and 224 cases per 100 000 people [11].

In 60% of cases, multiple sclerosis takes course of abatements and relapses, nevertheless, it is always of progressing, though hardly ever of instantaneous (sudden) nature.

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Immunosuppressive and immunostimulating treatment supplied so far does not produce the desired results. Symptomatic treatment basically consists in muscular tone reduction, ataxia or sphincters disorders [3,10,11].

In the USA and some European countries, treatment with the use of B-interferon or copolymer has been being applied for a few years, which does not bring the desired effect, either. Relatively high cost of such treatment in Poland limits its application further still [3,11]. Effective treatment of SM has not been found yet.

1.2. Reasons for the application of laser therapy in the treatment of multiple sclerosis.

The decision to apply laser biostimulation in the treatment of SM patients, made by the CDTL PŁ in November 1999, was arrived at on the basis of the following information:

1. In the light of CDTL PŁ's six years' experience in laser biostimulation applied in numerous diseases of various kind, the effectiveness of such treatment is estimated to be 80% [12].
2. Laboratory experiments results, first of which were published over ten years ago, prove beneficial influence of biostimulating lasers' light on acceleration of the nerve regeneration by stimulation of Schwann cells growth [2,4,8,15,16,17,18].

These two premises provided a basis for the attempt, made by our Centre in the cooperation with a team of neurologists from the Nicolaus Copernicus Specialist Hospital in Łódź, to subject the SM patients to laser therapy with the use of biostimulating helium-neon laser.

1.3. Laser therapy procedures in the case of multiple sclerosis

Laser biostimulation is applied to patients in different stages of a disease, mostly the ones with motor insufficiency over 5,5 points on Kurtzki scale(EDSS). The patients are subjected to several series of biostimulating laser irradiations, following the pattern elaborated for other diseases, earlier treated symptomatically with laser therapy with the use of helium-neon laser of 10 mW, i.e.21 daily contact sessions, lasting 10 min. each [13,20].

Anamnesis is taken from all SM patients. Besides, before and after the irradiation treatment all patients undergo neurological examination. Anamnesis is also taken half way through each series of irradiation.

SM patients, treated with laser therapy, stress general recovery, general (especially motor) fitness improvement, muscle strength improvement, and mental comfort improvement.

Sometimes, temporary deterioration of mental comfort accompanied by intensified pain is observed during the irradiation, most often between the sixth and the eighth session.

Such symptoms are reported by almost all patients subjected to biostimulating lasers irradiation, regardless their diagnosis; in nearly all cases they are connected with high effectiveness of biostimulation applied.

2. THE FIRST CLINIC TEST OF APPLICATION OF LASER BIOSTIMULATION TO SM PATIENTS

The initial results of the application of laser therapy in SM treatment, obtained during the first year of clinical experiments, suggested that it is going to be a new, effective method of treatment of this so far incurable disease.

The first group of SM patients, who were the first group subjected to laser biostimulation, consisted of 22 patients. This group was selected for the first test of clinical effectiveness of the application of laser biostimulation to SM patients, made by our Centre after 12 months' observation.

2.1 Materials and methods

22 patients with a diagnosis of a primarily or secondarily progressing form of multiple sclerosis were selected for laser therapy. These were patients suffering from this disease for many years, with a significant degree of disability. Each patient's disability was assessed on EDSS Kurtzki scale, and the minimum result necessary for entering the therapy was 5,5 points . Each patient's diagnosis was verified with magnetic resonance test (NMR), which identified foci of

demyelination. The analyzed group consisted of 19 females and 3 males, 35 - 60 years of age, the average age was 47,13 years, duration of the disease varied from 2 to 25 years, the average duration was 13,77 years.

The patients were irradiated with the use of helium – neon laser (632 nm) of 10 mW at the outlet of the light guide. Multipoint contact irradiation was applied. Each series of irradiation consisted of 21 daily (except Sundays) sessions, lasting 10 minutes each time. 12 patients out of this group were subjected to one series of irradiation, the rest of the group – two or three series, whereas in the case of the latter, the interval between each series of irradiation lasted two months.

After completion of each series, patients were subjected to neurological tests under supervision of the same doctor, who selected them for the therapy.

2.2 Results

After the completion of laser therapy the results obtained fell into three categories:

I-st – patients did not report any subjective tactile sensation improvement. Neurological tests did not identify any changes, either.

II-nd – patients reported subjective improvement, such as better appetite, numbness reduction, urination imperative reduction, while neurological tests did not identify any changes.

III-rd – patient reported subjective improvement, confirmed by neurological tests which also identified reduction of disability by at least 1 point on EDSS Kurtzki scale (which proves that the improvement could not have been reported as a result of a mere subjected sensation).

Thus, 7 (31,8%) patients were classed for the I- st group, 7 (31,8%) for the II- nd group, and 8 (36,4%) for the III- rd group.

Apart from their neurological condition, patients assessing the results of laser therapy they had undergone, stressed such changes as: muscular strength improvement, motor drive improvement, vitality, mental comfort improvement, lower ataxiae, better walking skill, muscular tone reduction, less frequent urinating during the day as well as during the night, balance improvement.

2.3 Discussion

Many of the above mentioned sensations are impossible to measure, but at the same time it is hard to assume that their only source were subjective premises. Objective improvement was reported by 1/3 patients, which is a good result, as it was reported by patients with far advanced disability, who had problems with basic everyday activities and with walking. Any improvement of neurological condition of these patients means significant facilitation in the above mentioned area for them.

The results presented are just the initial ones. Nevertheless, they are encouraging, as they were obtained from the SM patients with a stabilized, whether slight or serious, disability. These results prove high effectiveness of laser therapy. However, whether this effectiveness is the result of the mere advantageous psychogenic changes or of molecular structural changes, is not known. As well as whether these results are permanent or only temporary, and why the irradiation brings about such improvement. Such therapy has not been applied so far.

2.4 Conclusions

1. Initial results of laser therapy proved advantageous for 1/3 of the SM patients with the advanced disease and disability.
2. The results obtained make it advisable to continue our research.

3. LATER OBSERVATIONS AND RESULTS

Number of SM patients subjected to laser biostimulation is continually growing. Every year there are new patients, and although some of them give up laser therapy, their number gradually increases. At present, in CDTL PŁ, during the third year of the realization of the application of laser therapy in SM treatment programme, 100 SM patients are subjected to laser light, among whom there is a group of 50 patients irradiated continuously for three years.

Our presently conducted, much later than the first ones, observations show that in the case of application of biostimulating lasers in SM treatment, as well as in the treatment of other diseases, when laser biostimulation is routinely applied, definite improvement, or complaints abatement are usually reported after 3 –4 weeks after a completed series of irradiation. However, in the case of the application of laser biostimulation in SM treatment, too long intervals between the series of irradiation destroy the effect of an achieved improvement, both subjective - reported by the patients, and objective – identified by neurologists. In the case of SM patients, in which laser biostimulation causes symptoms regression, their renewed progression to the initial state, after quitting biostimulating irradiation, takes place after different periods of time. These observations prove that laser biostimulation is a highly effective method of SM patients rehabilitation, as it significantly improves SM patients' ability, even at a far advanced stage of the disease, without eliminating the cause of the disease.

4. EFFECTIVENESS OF THE APPLICATION OF LASER BIOSTIMULATION IN MULTIPLE SCLEROSIS TREATMENT IN RESPECT OF BIOLOGICAL EFFECT OF LASER LIGHT ON THE ANIMATE MATTER

Mechanisms responsible for the interaction between the effect of laser light on the animate matter are significantly different from mechanisms responsible for the effect of laser light with unanimate physical objects[5,6,9], as they are not dependent only on the parameters of a laser light beam, like: power, wavelength, pulse duration, or exposure time and incident beam section area, but they also depend, to a great extent, on the parameters characterizing biological object subjected to irradiation, such as absorption coefficient and scattering coefficient dependent on the wavelength of laser light used, medium density, its specific heat, and thermal conductivity. Besides, a very important role in a living organism is played by blood and lymph flow, thanks to which the radiant heat is carried away from the area of tissue subjected to laser light [1,4,13,19,20].

For example, in the process of the interaction between laser light and the tissue in the infrared radiation range, radiation energy is changed into rotational and vibrational molecular energy; in the visible radiation range peripheral (outer) electrons excitation is observed, and in the ultraviolet radiation range – inner electrons excitation. Thus, the results of the interaction between laser light and the animate matter are the resultant of numerous factors, a lot of which (much more than it is in the case of physical objects) is dependent on the parameters of the biological object [20].

The result most awaited by the doctors and desired by the patients is therapeutic effect. It is achieved through physical – chemical effect of laser light on biochemical structures of cells, which results in the change of their properties, and consistently – their activity. These changes, at first only qualitative, as laser radiation intensity and power increases, may cause destruction, at first reversible, then irreversible. Each type of these changes may, in particular circumstances, be a therapeutic effect [13,20].

The interaction between laser light and tissues fall into three categories: 1 – photo thermal 2 – radiation ionization (photo ionization) interaction, 3 – photo biochemical.

4.1 Photo thermal effects

Photo thermal effects are achieved at a power density of more than 1 W/cm2 and exposure time longer than nanoseconds. With these radiation parameters such effects may be achieved as: denaturation, coagulation, bleeding stoppage, incision and junction of tissues, ablation, etc. The quicker the energy is delivered to the tissue the less it affects the adjoining tissues. A precise incision requires high power density and short exposure time [4,20].

At a lower level of laser radiation intensity and power, thermal effect is also observed, as it always results from the extra amount of energy delivered by laser light. When this amount of energy is small and delivered gradually enough, than thermal effect does not excess compensation abilities of a cell. As the amount of the delivered energy grows, thermal effect may dominate biochemical effect in the cell, but it can be compensated at tissular level. As the amount of the energy still grows, thermal destruction goes beyond compensation abilities of tissue may lead to its destruction , or it still can be compensated at the level of organs [4,13,20].

Increase of molecular kinetic energy resulting from thermal effect may lead to the changes in the permeability of cell membranes, including cytoplasmic membranes, surrounding cellular organelles, and in the effect to the changes in enzymatic activity and in intercellular and intracellular transport [4,20].

4.2 Photo ionization effects

With the same power density and irradiation time of the order of nanoseconds and shorter we can observe photo ionization effects, including photo cleavage of bonds [4,20].

Most often, photo ionization leads to the change of the electric charge of molecules of organic compounds (proteins and enzymes), which may, in turn, cause changes in their activity, and consequently – changes in cellular metabolism. Changes of the electric charge within cell membranes result in the changes of their permeability and conduction, e.g. in nerve cells. Whereas photo cleavage of bonds may result in the formation of new chemical compounds, which means it can cause significant changes in cellular metabolism [4,20].

4.3 Photobiochemical effects

They are observed at power density of up to 1W/cm2, and relatively long exposure time, of the order of microseconds or longer. These are irradiation parameters used in biostimulation. According to the present state of knowledge two different mechanisms can be distinguished in photo biochemical interaction. These are: photochemical effect and biochemical resonance effect.

4.4 Photochemical effect

Consists in selective and specific reaction of natural pigments present in tissues at particular wavelengths of electromagnetic light. These pigments are called photosensitizers, which is not a very precise term. They are, for example: hemoglobin and melanin. From the evolutionary perspective, the basic photosensitizer is chlorophyll, whose biological action is activated by an irradiation wave in the range of ultraviolet. Another example of photochemical effect of light is the mechanism of vision activated by the visible radiation in the range of only 300 nm (from 400 to 700) causing decomposition of proteins in pigmentary cuticle of retina. Enzymatic systems such as cytochromes also belong to photosensitizers. Besides, various products of metabolism (eg. Precursors and derivatives of hemoglobin) can become photosensitizers as well. It is also possible that in the case of an illness some blood proteins take on photosensitizers' properties. This may provide an explanation for empirically confirmed completely different reaction of a healthy and an ill organism to the same wavelength of laser light [4,13,20].

There is also a group of photosensitizers obtained synthetically which when introduced into an organism can, depending on the place of their accumulation in tissues, cause completely different effects of exposure to laser light than the ones obtained without it [13,20].

4.5 Biochemical resonance effect

Consists in "forced" spatial molecular reorientation of organic compounds (e.g. enzymes) by homogenous vibration of laser light, which in turn causes significant increase of their biological activity. A good example illustrating this resonance is construction of a bridge. It endures the highest pedestrian and vehicular traffic volume on condition that each of the objects moving across it generates its own individual rhythm of vibrations of varying frequency and intensity. They counterbalance and deaden one another, and extensive vibrations are absorbed and eliminated by the inert construction of the bridge.

Whereas a small squad marching across the same bridge at a uniform pace generates increasing vibrations of the same construction forced by the rhythmic, coherent and homogenous vibrations of this "outer object". This leads to an inevitable collapse of the bridge if the resonance of these vibrations is long enough. Thus, biochemical effects formed in the cellular structures as a result of the impact of the laser light consist also in the change of special orientation of organic molecules when exposed to the specific frequency of laser light vibration. This may lead to an increase of activity of individual enzymes, or the whole enzymatic systems in these cellular organelles which constitute natural resonator of light waves of specified lengths (frequency of their vibrations).

Then we can observe activation of e.g. breathing enzymes in mitochondria or digestive enzymes in lysosomes [13].

Mechanisms of the impact of laser light on the living tissue depend on the one hand on its physical properties [4,5,6,9,19] and on the other hand – on the kind of tissue, degree of diversification of the cells forming a given tissue, and on physiological condition of cellular organelle in individual cells [1,4,13,19,20].

Thus, the effect of the impact of laser light on an organism is a resultant of physical properties of a laser and physical chemical properties of a cell exposed to the light.

Interference of laser light in a living organisms starts at a molecular level. Changes observed at this level alter the action of particular structures of a cell (e.g. cellular organelle), which in turn brings about significant changes in the activity of cells, which means a change of their properties, and consequently a change of the properties of a tissue. This leads to changes in a given organ and finally to the changes in the whole organism [4,13].

Exposure of biologically differentiated tissues to laser light of various kinds and various physical properties may result in various composition of these changes, which may give completely different effect of the reaction of an irradiated tissue in each case [13].

Numerous experiments of various kinds conducted on laboratory animals and tissular cultures with the use of laser light produced various biological effects [1,4,13,14,15,16,20]. Variety of these effects is enormous.

At the present state of knowledge, therapeutic effect of lasers is in many cases beneficial as it allows an effective rehabilitation of chronically ill patients, replacement of operative procedures requiring hospitalization with an ambulatory, conservative treatment (which significantly shortens the treatment time as well as reduces its costs), and also makes it possible to treat so far incurable illnesses [13,20].

5. CONCLUSIONS

Objective clinical results obtained from patients suffering from multiple sclerosis as well as subjective improvement of their mental comfort and motive power suggest that laser biostimulation is not only an alternative method of therapy of SM patients but also an effective method of rehabilitation in this so far incurable disease. In the future it may prove to be an even more effective method of therapeutic rehabilitation in multiple sclerosis than it is presently assumed, and undoubtedly much cheaper than therapeutic procedures used so far (interferon). The annual cost of laser therapy for one patient is several hundred times lower than it is in the case of interferon, whose effectiveness in the therapy of multiple sclerosis is questioned by many neurologists.

All this points to the need to continue our clinical experiment and research aimed at explaining pathomechanisms and clinically beneficial influence of laser light in the case of multiple sclerosis.

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