LOW LEVEL LASER THERAPY (LLLT) FOR CEREBRAL PALSY

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Spasticity in cerebral palsy (CP) patients is a critical factor preventing voluntary movement, and can also be associated with involuntary clonus. Low reactive-level laser therapy (LLLT) has been reported as having good overall efficacy in CP patients and also in controlling clonus. The present study was designed to evaluate LLLT in the clinical setting to attenuate spasticity in severely handicapped CP patients. We treated 20 CP patients with near infrared (830 nm) LLLT (16.2 J/cm²/point, once/week over 10 weeks) as a clinical study at our university hospital and a hospital connected with our university. For spasticity of the hip adductor muscle, the obturator nerve was the target for LLLT, and the tibial nerve was irradiated in the case of triceps surae muscle spasticity. LLLT was indicated for the 10 sessions and the degree of attenuation of spasticity was assessed after the final session. Some degree of efficacy and treatment latency was seen in 14 (70%) of the 20 patients, 5 evaluated as excellent, 6 as very good and 3 as fair. Little or no change was seen in the remaining 6 patients, and in no patient did the symptoms worsen. We concluded that LLLT was an efficacious treatment option in the conservative treatment of CP patients, that it was easily-applied, non-invasive and pain-free, and that it did not have any adverse side effects.

Key Words: Low level laser therapy, cerebral palsy, spasticity, clonus

Introduction

There are several types of cerebral palsy (CP), such as the spastic type, athetotic type, mixed type, hypotonic type, ataxic type, and so on. The spastic type involves severe spasticity characterized by increased tone in the affected muscles resulting in resistance to passive stretch, velocity-dependent and asymmetric about joints. Exaggerated deep tendon reflexes and clonus are additional manifestations. Severe spasticity is a critical preventative factor for facilitating voluntary movement conservative treatments have been indicated in the attenuation of patient spasticity, such as medication, therapeutic exercise, bracing, Botox muscular

injection, phenol nerve block and so on.

In 1985, Walker reported that low level laser therapy (LLLT) attenuated the clonus element of spasticity.⁽¹⁾ Following this, our group reported that LLLT efficiently attenuated spasticity caused by pyramidal tract disorder of brain and spinal cord.⁽²⁾ The purpose of the present investigation was to evaluate LLLT effects in the treatment of CP patients in terms of spasticity attenuation.

Subjects and Methods

Subjects

Twenty patients with the spastic type of CP comprised the study subjects, who had been treated in our university hospital and a hospital connected with our university, from 2001 to 2006 (**Table 1**). All patients were severely physically handicapped, and had been issued

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Table 1: Case Outlines of Cerebral Palsy Patients

case	age	sex	Paretic type	Irradiation part*	Locomotive Function	Frequency of Ankle Clonus Indication		evaluation
						Before irradiation	After irradiation	
1	6	M	paraplegia	T	cane gait	4	0	excellent
2	4	F	tetraplegia	T, O	bedridden	6	2	good
3	5	M	hemiplegia	T	self gait	5	1	excellent
4	22	F	paraplegia	T	cane gait	10	5	good
5	8	F	paraplegia	T, O	cane gait	successive	5	good
6	13	M	paraplegia	T	wheelchair	8	8	no change
7	10	M	tetraplegia	T, O	wheelchair	7	7	no change
8	7	F	tetraplegia	T, O	wheelchair	5	5	no change
9	17	F	tetraplegia	T, O	wheelchair	6	2	fair
10	19	M	tetraplegia	T, O	wheelchair	7	2	fair
11	29	M	tetraplegia	T, O	bedridden	7	6	no change
12	15	M	hemiplegia	T	self gait	6	1	excellent
13	14	M	hemiplegia	T	self gait	6	4	fair
14	17	M	hemiplegia	T	self gait	7	1	excellent
15	23	F	paraplegia	T	cane gait	5	5	no change
16	24	M	paraplegia	T	cane gait	6	2	excellent
17	4	M	paraplegia	T	cane gait	4	1	good
18	8	M	paraplegia	T	cane gait	5	2	good
19	14	F	paraplegia	T	cane gait	6	2	good
20	16	F	paraplegia	T	cane gait	6	6	no change

*(T : Tibial nerve, O : Obturator nerve)

with Physically Handicapped Person's Certificates from grades 3 to 1. There were 12 male patients and 8 female patients. Ages ranged from 4 to 29 years old, with an average age of 13.8 yr.

The study was conducted under the principles of the Declaration of Helsinki (2004). After having had the study explained to them in full, all patients, or their families where appropriate, gave written informed consent to participate in the study.

Methods

The LLLT system used was a gallium aluminum arsenide (GaAlAs) diode laser (MDL-2001, Matsushita Electric Corporation, Tokyo, Japan), delivering 60 mW at 830 nm in continuous wave, with optional frequency modulation settings. CW was used in the present study. The spot size at tissue was 1.4 mm in diameter, and the incident power density or irradiance was 60

Fig. 1: LLLT irradiation targets
Left side x mark: obturator nerve
Right side x mark: tibial nerve

Table 2: Low Level Laser Therapy device Specifications

Laser Element	Semiconductor Laser Diode Ga-Al-As: Gallium – Aluminum - Arsenide
Model & Manufacturer	MDL-2001 model Matsushita Electric Corporation, Tokyo, Japan
wavelength	830 nm $\pm$ 5 nm
output	60 mw $\pm$ 20%
mode	continuous wave mode
irradiation time	30 sec.
energy density	16.2 J / cm ²
power supply	100 VAC, 50-60 Hz

mW/cm² (**Table 2**).

The target points for LLLT irradiation were the obturator nerve which innervates the hip adductor muscle, and near the tibial nerve which innervates the triceps surae muscle (**Fig 1**). The laser handpiece was applied with mild pressure to the skin over these targets. Each treatment session consisted of 3 irradiations over each target of 30 sec each, delivering an energy density or radiant fluence per point of 16.2 J/cm². We irradiate the same target points three times each. Treatment sessions were once per week for 10 weeks.

We evaluated the immediate effects after each session, and the and lasting effects after the final session. **Table 3** shows the evaluation criteria. To evaluate the immediate effects, we checked changes in the frequency of ankle clonus indication before and after each irradiation, and the range of motion (ROM) of the hip joint and ankle joint.

To evaluate the latency of the effects after the 10th irradiation, we continuously assessed changes in the patients' gait pattern, any reduction in the amount of family assistance required (dressing/undressing, support of sitting position), and how much the patients' families were satisfied with the treatments.

Results

Results were evaluated as excellent, good, fair, little or no change or worse, as shown in **Table 3**. Fourteen of the 20 CP patients showed some degree of change, with 5 cases evaluated as excellent, 6 as good, and 3 as fair. In the 6 remaining patients, little or no change was seen but their conditions did not worsen, and there were not any side effects.

Cases with excellent effects had the following improve-

Table 3: Effect Evaluation Criteria

excellent	- the duration of the effect was more than 1 day - significant reduction in the frequency of ankle clonus indication
good	- the duration of the effect was 1 day or less - some reduction in the frequency of ankle clonus indication
fair	- subjective improvement
no change	—————
worse	- pain - sensory disturbance - side effects, etc.

ments: disappearance of ankle clonus

- increased range of joint motion (ROM)
- effects lasting for more than 1 day

Cases with good effects had the following improvements:

- frequency of ankle clonus indications decreased.
- improved gait pattern
- effects lasting less than one day

Cases with fair effects had the following improvements:

- no change in the frequency of ankle clonus indications
- subjectively attenuated spasticity of legs
- putting on a brace more easily managed

In terms of duration:

- We were able to investigate to what degree treatment could lessen the frequency of ankle clonus indications as one of the immediate effects
- As for the lasting effects, we had 5 cases with excellent effects which lasted for more than 1 day. However, in the cases which were evaluated as good and fair the improvements lasted less than 24 hours.

From these results, we concluded that patients need adjunctive therapeutic exercise, bracing or home exercise after LLLT irradiation to enhance the efficacy of the LLLT.

Discussion

Reports in the literature which have examined the effect of LLLT in reducing spasticity in CP patients are sparse. Among the conventional spasticity attenuation

treatments that we have carried out so far, medication is efficacious, but it also has bad points. Since medication exerts its effects systemically on the muscles in general muscles, it can cause a decline in general muscle tone and voluntary movement. Therefore, patients' voluntary movement can be less smooth.

Therapeutic exercise has the potential improve the psychological relationships between patients and their physical therapists and their families. On the other hand, physical therapists need to be well-trained regarding their exercise skills. In addition it is sometimes difficult to educate families properly and it is moreover difficult to motivate patients to perform their therapeutic exercises regularly and consistently.

Bracing is effective when the brace is prescribed, produced, and fitted properly. However, the application process under the Japanese government's health insurance scheme is complicated. Botox intra-muscular injections into the spastic muscle are technically easy, yet Botox solution is expensive, so patients are financially constrained to have this approach performed as and when they want it. As another injectable approach, phenol nerve block is effective but it is technically a little complicated and it causes pain.

The relevant literature shows us that Asagai reported the efficacy of LLLT in attenuating spasticity caused by the tension athetotic type of CP,⁽³⁾ and Furukawa also reported that it LLLT was efficient for attenuation of CP-related spasticity.⁽⁴⁾

Cook developed a robotic system to facilitate the development of patients with severe physical handicaps,⁽⁵⁾ but it has unfortunately not yet been applied in the clinical therapy situation.

Moreira has reported that LLLT was effective in treatment of the spastic type of CP⁽⁶⁾ On the other hand, Lopriore and colleagues reported that they were unable to definitively conclude that LLLT actually facilitated the neurological development in infants,⁽⁷⁾ when they irradiated fetuses with LLLT. Though the mechanism by which LLLT can attenuate spasticity remains to be concretely clarified, from the existing literature we can surmise that LLLT has a direct action on the peripheral nerves which innervate the target spastic muscle, and that blood supply to the muscle and surrounding tissue is improved; LLLT exerts control of neurological function, in particular autonomic nerve control through which sympathetic hypertension is replaced with parasympathetic dominance. However, even more research is required before these mecha-

nisms can be absolutely proved.

However, we consider that LLLT involves autonomic nerve control and leads to spasticity attenuation. We have been able to reach this viewpoint based on the result of a 1986 investigation which examined fluctuation of pulse wave baseline changes before and after treatment⁽⁸⁾ In any case, the mechanism of spasticity attenuation by LLLT is a problem which certainly merits further detailed study.

While study reports based on Evidence Based Medicine (EBM) have been released up until now, Greenhalgh introduced the idea of Narrative Based Medicine (NBM) in 1998.⁽⁹⁾ It states that it is natural for physicians to receive informed consent before choosing a treatment. They warned that it is difficult for physicians to create reliable relationships with patients through EBM based partial medical treatment.

It is not easy to explain NBM briefly. Basically, we understand that it is to bring "Patient Based Medicine" into clinical therapy in all medical care for patients. "Patient Based Medicine" is founded on the patients' words, the patients' ways of talking, patient-based treatments, treatments considered through patients' point of view, and so on.

In Western countries the idea of NBM introduced by Greenhalgh has continued to penetrate gradually into clinical therapy from the late 20th century to the beginning of the 21st century. Recently, we can see more reports about the importance of the shift from EBM. For a reference to more details about NBM, please consult Greenhalgh's textbook. In those contexts, patient-based treatment is seriously required for those who supply medical treatment.

After patients received LLLT treatment for spasticity attenuation, the patients and their families showed their appreciation. However, we were not able to approach patients well, in terms of the essence of NBM. Therefore, we will try to apply the idea of NBM to clinical therapy in treating patients from now.

Conclusions

We treated 20 CP patients with LLLT, and in 14 (70%) of them recognizable effects were seen. Since the duration of the effects was short, however, we have started to educate the patients' families in proper therapeutic exercise, bracing, and home exercise in order to further improve the good effects achieved by LLLT on its own in the present study.

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