APPLICATION OF LOW REACTIVE-LEVEL LASER THERAPY (LLLT) IN PATIENTS WITH CEREBRAL PALSY OF THE ADULT TENSION ATHETOSIS TYPE

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In patients with cerebral palsy of the tension athetosis type, a number of symptoms may be observed, including not only the fairly constant involuntary athetotic movements but also myotonic disorders of the motor function of all four limbs and trunk, vocalization and motions associated with eating such as mastication and swallowing. Aggravation of involuntary movements and pain in the neck and back are also seen in many cases. Existing conservative treatment methodologies have proved to be more or less ineffective, and limitations in functional training in adults have made treatment extremely difficult. We first employed low reactive-level laser therapy (LLLT) in a case of spastic cerebral palsy in 1994 with good results. In the present study, we applied laser irradiation (830 nm, 60 mW continuous wave) to all myotonic sites around the face and neck region where myotonia was severe in 20 patients with cerebral palsy of the adult tension athetosis type for which there was no effective treatment for their neck and back pain. Improvement of myotonia was seen in 19 patients while improvement of pain in the neck and back was seen in all the 16 patients who had pain in these regions. Suppression of myotonia reduced tonic vocalization making words easily heard; moreover, suppression of myotonia and involuntary movements improved working efficiency enabling the patient to perform fairly complex tasks such as word processing. Insomnia and dysuria also improved. Even in the most severe cases, assisting the patient became easier and breathing improved. LLLT with the 830 nm diode laser provides a new and effective treatment modality in this extremely problematic condition, has no serious side effects, and has the potential to improve these patients' quality of life.

Key words: Low reactive-level laser therapy, cerebral palsy, adult tension athetosis type, rehabilitation, pain attenuation, functional training

Introduction

We have reported that low reactive-level laser therapy (LLLT) suppressed tonic muscle spasm in children with spastic cerebral palsy and improved the efficiency of their functional training.^(1,2) Pain of the neck and back is often observed in patients with cerebral palsy of the

adult tension athetosis type and at present there is no really effective conservative conventional therapy. Indeed some treatment methods result in aggravation of the involuntary constant slow writhing movements associated with athetosis, and the pain caused by increased myotonia. We have used LLLT in patients affected by this disease to suppress neck and back pain as well as systemic myotonia since 1994, and obtained

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good results. The present study will present representative case reports.

Subjects and Methods

Subjects:

The subjects were 20 patients with cerebral palsy of the tension athetosis type (mean age: 32 years; range: 20-53 years). Neck and back pain was seen in 16 cases. As for their motor function level, 11 patients could walk while the others were unable to walk and were relied entirely on assistance for their daily life; Three from this latter group could not even hold themselves in the sitting position.

Laser:

The laser apparatus used was a GaAlAs diode laser, (OhLase-3D1, Proli Japan: 830 nm, 60mW output and continuous wave) (Figure 1). Referring to Ohshiro's proximal priority method,⁽³⁾ in which treatment is applied from the proximal to distal areas, relevant acupuncture points, nerve block sites and muscle tendons showing severe myotonia were irradiated for 30 seconds at a time, for 15 to 30 minutes in total while placing emphasis in treating the face and neck regions where myotonia was observed from the centre out to the periphery (Figure 2). Direct irradiation of the eye or irradiation of non-myotonic sites was avoided. The laser was applied in the contact method with mild pressure

to increase the penetration capabilities of the 830 nm beam by compressing out the superficial microvasculature. Laser irradiation was performed once a week for outpatients or every day for a period of 2 weeks to 1 month for 11 inpatients, and was delivered together with functional training. The longest period of irradiation was 1 year and 6 months. Before and at the end of treatment, voluntary movements were recorded on videotape, the patient's pain score and the R-R interval (i.e. the elapsed time between two QRS complexes) on electrocardiograms were determined, and thermography and facial electromyography were carried out.

Results

Systemic myotonia was suppressed after irradiation in 19 patients, and neck and back pain ameliorated in the 16 patients who had been suffering from pain. If the pain score before irradiation was set at 10 points, the score after irradiation was between 0 and 3 in 6 inpatients who showed excellent effects, between 4 and 7 in 2 inpatients and 6 outpatients who showed good effects and between 8 and 9 in 2 outpatients in whom the LLLT was graded as minimally effective (Table 1). No patient failed to show even slight improvement or got any worse. In 2 patients who were followed up over a long period, although the therapy was extremely effective during hospitalization, the 'excellent' efficacy of the

Fig 1: The Oh Lase-3D1 diode laser therapy unit. The easy-to-hold handpiece is connected to the control console by a flexible cable.

Table 1: Evaluation of treatment based on decrease of pain score in 16 patients with bad pain.

Pain score	Inpatients n=8	Outpatients n=8
Extremely effective: 0~3	6	0
Effective: 4~7	2	6
Slightly effective: 8~9	0	2

Table 2: Improvement of symptoms after LLLT.

Symptom	No. of patients
Systemic suppression of myotonia	18
Improvement of pain	15
Warming of the whole body	12
Prolongation of vocalization time (improvement of language disorder)	8
Improvement of asymmetric posture	8
Improvement of activities of daily living	5
Improvement of insomnia	4
Improvement of dysuria, constipation, working ability of the upper limbs and involuntary movements	2
Reduction of the oral dose of muscular relaxant, and improvement in difficulties associated with opening of the mouth	1

treatment lasted for only 2 or 3 days after irradiation after which patient became an outpatient, gradually returning to the pretreatment condition.

Pain increased again after 1 month following the conclusion of the first therapy period whereafter the patients were hospitalized for a second time. Following the retreatment, improvement of myotonia and pain, mainly while warming of the whole body, was seen in 12 patients, prolongation of vocalization time in 8, and improvement of asymmetric posture in 8 (Table 2). Two patients, one in whom evaluation of the efficacy of therapy was difficult due to marked mental retardation and another who could not hold himself in the sitting position due to severe suppression of myotonia, did not wish to undergo a second session of LLLT. The effects of LLLT lasted for from 2-3 hours to 1 week and the duration was prolonged by 2-4 days at the longest by continuous irradiation.

Thermography was performed in 7 patients. Skin temperature in the face, trunk and upper limbs rose 2°C - 7°C in three of the seven while in two others, whole body warming was seen. The temperature increase lasted for more than 1 hour (Figure 3: see together with Figure 8 on page 117). The remaining two patients in whom the temperature did not rise after the initial irradiation session also showed a rise of skin temperature after 1 month of continuous irradiation.

The R-R interval determined by electrocardiography was used to evaluate autonomic nerve function. A decrease in the standard deviation of the R-R interval and coefficient of variance were observed in 5 cases and

Fig 2: Schema of LLLT target points. All the regions with myotonia, especially in the face, neck and back, were irradiated.

Fig 4: A 31 year-old female patient with cerebral palsy of the tension athetosis type. (a,b): Before LLLT. (c,d): After LLLT. LLLT and functional training were given every day for 1 month. Neck and back pain as well as involuntary movements in the face and neck were improved.

Fig 5: Superficial electromyography of the trapezius muscle at the time of vocalization in a 31 year-old female patient with cerebral palsy of the tension athetosis type. Above: right trapezius muscle and below, left trapezius muscle. Left, before LLLT and right, after LLLT. Decreased electric discharge seen post-LLLT.

Fig 6:

A 33 year-old male patient with cerebral palsy of the tension athetosis type. (a,b): Before LLLT. Asymmetric posture was seen as well as severe myotonia in the face and the patient could not open his eyes unless he pulled up the upper eyelids with his hands. (c,d): After LLLT. LLLT and functional training were given every day for one month. Neck and back pain were ameliorated and eye opening became easier. Symmetric posture was readily taken and motions associated with eating became easier.

the effect on the autonomic nervous system as indicated by these data was suggested as part of the action mechanisms of the diode laser LLLT.

The only side effects seen were temporary aggravation of posture maintenance due to severe suppression of myotonia in 2 cases and asthenia in 3 cases, but no serious side effects were observed.

Case Reports

Case 1: 31 year old female (Figure 4):

This patient was hospitalized so that she could receive continuous LLLT and functional training. Her neck and back pain improved; extreme rotation of the right side and involuntary movements, recorded as occurring approximately 20 times per minute on average at the time of hospitalization, disappeared completely, as a result of which her ability to work usefully increased dramatically, including the ability to use a word processor. Dysuria and insomnia improved and tonic vocalization decreased making words much easier to hear. Thermography demonstrated an increase of the skin temperature of the hands as well as of the face and trunk.

Electrical discharge from the sternocleidomastoid muscle in the sitting position decreased after irradiation, as shown by electromyography. Electrical discharge from the trapezius muscle at the time of vocalization also decreased indicating suppression of involuntary movements and myotonia (Figure 5). The mean duration of 5 vocalizations was clearly prolonged from 4 seconds before irradiation to 7 seconds after 2 weeks of treatment. After mock irradiation using a probe exactly similar to the real probe, that emitted the audible emission indicator but without laser irradiation, the duration of vocalization did not change.

Case 2: 33 year old male: (Figure 6)

The patient was hospitalized for 1 month and was given LLLT and functional training every day. The patient had an asymmetric posture, severe facial myo-

Fig 7: A 38 year-old male patient with cerebral palsy of the tension athetosis type. (a,b): Before LLLT. The patient had severe quadriplegia with extreme systemic myotonia and had difficulties in taking the lateral position. (c,d): After LLLT. Systemic myotonia was suppressed after first session of LLLT

Fig 3: Results of thermography before and after LLLT in a 28 year-old female patient with cerebral palsy of the tension athetosis type. (a) Before LLLT. (b) 30 minutes after LLLT. (c) 60 minutes after LLLT. (d) 90 minutes after LLLT. The rise in systemic skin temperature reached a peak of 4°C after irradiation and lasted for more than 1 hour.

Fig 8: Results of thermography before and after LLLT in a 38 year-old male patient with cerebral palsy of tension athetosis type. (a) Before LLLT. (b) 30 minutes after LLLT. (c) 60 minutes after LLLT. The skin temperature in the face, trunk and upper limbs increased 30 minutes after LLLT. After 60 minutes, the upper limbs which had not been observed before LLLT could be seen and an increase of 4°C in the skin temperature was noted.

tonia and could not open his eyes unless he pulled up the upper eyelids with his hands. After irradiation, neck and back pain ameliorated, it became easier for him to open his eyes and adopt a more symmetric posture, and movements associated with eating, i.e. mastication and swallowing, also improved and became more natural.

Case 3: 38 year old male (Figure 7):

This patient had severe quadriplegia with marked systemic myotonia and had difficulties in lying on his side. After irradiation, systemic myotonia was suppressed and assisting the patient became easier. Breathing also improved. Thermography showed an increase of the skin temperature in the face, trunk and upper limbs after 30 minutes of irradiation. After 60 minutes, the upper limbs which had not been observed on the screen before irradiation were clearly seen after treatment indicating the skin temperature had risen 4 degrees (Figure 8).

Discussion

Since our first report on LLLT for spastic cerebral palsy, the usefulness of this therapy has been reported mainly in Japan. In the past, oral administration of a muscle relaxant or a tranquilizer, collar fixation of the neck and traction of the cervical vertebrae were performed in an effort to deal with myotonia and pain in tension athetosis, but effective conservative modes of treatment for the disease were scarce. Treatment was difficult and not a few cases resulted in cervical spondylosis and cervical radiculopathy. We have developed a new therapy wherein the face or neck is irradiated smoothly with contact laser therapy in the proximal priority method, using the 830 nm OhLase-3D1. Myotonia, improvement in control of wide-ranging involuntary movements

and improvement of training effect is observed even in adults when LLLT is combined with functional training. The hand-held probe of OhLase-3DI weighs 300g, therefore it is easy to exert adequate pressure on the skin at the target point, and to maintain the slight pressure without the operator's becoming fatigued. The laser aperture at the tip of the probe cap is fitted with an antireflective window and thus it facilitates smooth irradiation of the body surface. We observed the best effect in comparison to another GaAlAs diode laser with the same output power, but without the probe cap window. In this latter system it was difficult to move the probe smoothly from point to point, and reverse osmosis caused the appearance of small red lumps in the irradiated area when any pressure was applied.

In this study, suppression of myotonia lasted for 2 or 3 hours in the face and neck, where myotonia was severe, while it lasted for several days to 1 week in other regions; moreover, prolongation of the suppressive effect was seen to a certain extent after repeated irradiation. This increased latency effect has been commented on by other researchers, see for example Moore and Calderhead⁽⁴⁾ and Ohshiro.⁽³⁾

As for side effects, asthenia was seen in two patients due to systemic irradiation but this problem was solved by reducing the duration of irradiation or its frequency. In one case in which myotonia was not so marked, it was hard for the patient to hold his head and trunk temporarily due to suppression of myotonia while a temporary slight augmentation of involuntary athetotic movements was observed after irradiation. Neither the so-called athetose shift, that is an increase of the involuntary movements in regions other than the region where involuntary movement is temporarily suppressed, nor severe side effects, was observed. While there was not a single case in which myotonia was aggravated by LLLT, the patient's cooperation is important in cases of adult type athetotic cerebral palsy because otherwise it is extremely hard to obtain a therapeutic effect. From our cases, 18 patients out of

the original 20 were willing to try further LLLT after their initial session.

Conclusions

We conducted LLLT in 20 cases of cerebral palsy of the adult tension athetosis type which has been extremely difficult to treat in the past. Improvement of myotonia was observed in 19 patients and amelioration of neck and back pain in the 16 patients who had been suffering from neck and back pain. The duration of sustained effect varied from 1 or 2 hours to a week and it was prolonged by further irradiation sessions. Temporary aggravation of posture maintenance due to suppression of myotonia and asthenia were observed as side effects but no severe side effects were seen. Effect on the autonomic nervous system was suggested as one of the action mechanisms of diode LLLT. LLLT proved very useful in patients with cerebral palsy of the adult tension athetosis type, is easy to apply, is pain-free, is serious side-effect free, and is very well tolerated by patients.

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