International Journal of Physical Medicine & Rehabilitation

Asagai, Int J Phys Med Rehabil 2016, 4:1
DOI: 10.4172/2329-9096.1000320

Mini Review Open Access

24 Years' Experience of Low Level Laser Therapy (LLLT) for Children with Cerebral Palsy

Yoshimi Asagai*

Department of Orthopedic Surgery, Shinano Handicapped Children's Hospital 6525-1 Shimosuwa, Suwagun, Nagano, Japan

***Corresponding author:** Yoshimi Asagai, Department of Orthopedic Surgery, Shinano Handicapped Children's Hospital 6525-1 Shimosuwa, Suwagun, Nagano, Japan, Tel: 0266-27-8414; Fax: 0266-27-7936; E-mail : asagai@shinano-iryo.or.jp

Received date: December 14, 2015; **Accepted date:** January 13, 2016; **Published date:** January 19, 2016

Introduction

Since 1991, phototherapy (low-level laser therapy, near-infrared ray therapy and light-emitting diode: LED therapy) has been used in the management and rehabilitation of patients with various orthopaedic diseases. The laser used was a gallium aluminum arsenide (GaAlAs) diode laser giving output powers in continuous wave of 100 mW, at a wavelength of 810 nm. The target points were the acupuncture and the nerve block points, where the myotonia was observed, and the irradiation was performed daily. Each site was irradiated for 1 minute, with a total irradiation time of 20 minutes in total per day with contact method. The spot size at the tissue was 1.04 mm^2 giving power densities of 9.61 W/cm^2 at 100 mW. Energy densities were 288.3 J/cm^2. When compared with patients at other training sites, where only functional training therapy was applied without LLLT, the efficacy of functional training was clearly enhanced by combination with LLLT [1,2].

Duration of the Effect of LLLT

The suppressive effect of LLLT on myotonia was sustained from 23 hours to around 1 day, and it was considered that the duration of the effect might depend on the individual sensitivity to the laser irradiation, as well as on the individual severity of the myotonia. The cumulative effect by repeated irradiation cannot be expected.

Mechanism of Actio

Increase in blood flow is one such easily measureable reaction to light. In a previous study, we analyzed the changes in the superficial skin temperature in response to light using thermography. LLLT directed on the gohkoku acupuncture point. A maxim rise of 9 degrees Celsius was noted in skin temperature after irradiation, but peak temperature remained normal range [3]. We have conducted a quantitative study on the changes in the blood flow in the common carotid artery using Doppler ultrasonography revealed that the blood flow on the light-irradiated side increased by an average of 23.5% and to a maximum of 74% and the flow on the non-irradiated side increased by an average of 31.6% and to a maximum of 70.7% [4]. With regard to the effects of light on the autonomic nervous system, children with cerebral palsy showed changes such as improved sleep rhythms and temperature rise in extremities.

Recent studies have shown that phototherapy exerts the following effects as well: (1) suppression of the excitation of the sympathetic nervous system, (2) dilatation of arterioles and increase in the blood flow through arterioles [5], (3) direct action on blood vessels by reduction the concentration of free Ca^{2+} ions within vascular smooth muscle cells, (4) induction of the opening of Na channels and depolarization in the nerve fibres, and so on.

Adverse Reactions

No serious adverse reactions were observed for the laser irradiation, only direct irradiation to the eyeball being prohibited. In the 2 patients with severe encephalopathy and affected autonomic temperature regulation, the body temperature was temporally elevated after the laser irradiation.

Histological study of muscles

During the orthopaedic surgical procedure (tendon lengthening), open biopsies were obtained from hip adductor muscles. 95 biopsies were obtained from 42 individuals. After LLLT we can find dilatation of capillaries. All of them were not degenerative change [6].

The Know-How of LLLT

The myotonia-suppression effect is expected immediately after the irradiation, and it is easily confirmable by the physical therapist and the mother. The laser irradiation is not effective for regions where irreversible joint contracture occurs. The laser irradiation before the slow stretching training is useful because the pain associated with the stretching is suppressed.

Characteristics of LLLT

Despite the temporal suppression effect for myotonia, it is useful as a supplementary treatment to functional training for cerebral palsy. The laser irradiation method is simple, and the myotonic suppression of any sites on the body is possible within a short time. The irradiation is completely free from pain or serious adverse reaction.

The efficacy of intensive functional training with LLLT

GMFM (Gross Motor Function Measure) was assessed twice, at admission and discharge. The training effect combined with LLLT was clearly enhanced when compared with the cases of intensive training at other sites where no LLLT has been performed (Gross Motor Function Classification System: GMFCS level IV with LLLT n:21; GMFM 9.71 ± 3.81 vs. without LLLT n:20; GMFM 3.85 ± 2.98) ($P<0.05$). The patients' age were 2-7 years, mean of 4 years and 6 months, and the assessment period was 2months [7].

At the time that they left the facility, we conducted a survey of mothers who had entered the facility together with their children used LLLT. We conducted a five-tiered evaluation of the extent of their satisfaction and of their answers to the various questions. There were

452 (GMFCS level III: 36cases, IV:114cases, V: 302cases) respondents. According to the results, 91% were satisfied or somewhat satisfied; 87% thought, or thought to a certain extent, "There was a positive change in my child, and I saw improvement in the way my child functioned." The importance of the role played in rehabilitation by mothers and children entering the facility together thus became clear.

The reason why LLLT is useful for functional training in spastic type cerebral palsy

The laser irradiation might act as a trigger for improving the imbalance of the antagonistic muscles, thus LLLT can be positioned as supplementary treatment for enhancing the effect of functional training.

Other Applications to bone and joint disease

For other applications of LLLT, the following indications are effective: suppression of myotonia in the tonic athetotic cerebral palsy [8], suppression of femoral head deformation, and reduction of therapeutic period for Perthes disease [9], for congenital hip dislocation, improvement of the limitation of abduction in flexion of hip joint by suppressing myotonia focusing in adductor magnus muscle of the hip, and application for pre-treatment before using Pavlik harnes [10,11].

The possibility of the application of LLLT in patients with osteoporosis: Patients with severe cerebral palsy are susceptible to pathologic fractures and are likely to develop intractable osteoporosis. We analyzed the changes in markers of bone metabolism after LLLT [12]. Light-Emitting Diode (LED) irradiation normalized values of IGF-1 related to bone growth, and BAP and NTX/Cr related bone density. LED irradiation increased bone density and improved femur cortical bone thickness and bone age [13,14].

Application to patients with skin necrosis or bed sores: A patient had skin necrosis and was examined at a local clinic and recommended skin transplantation. Application to patients with congenital clubfoot: The application of LLLT and corrective massage before the correction of deformities with a cast facilitated the correction, enabling further improvement in congenital clubfoot [6].

Conclusion

1) In 1991, we introduced low level laser therapy (LLLT) as a new therapeutic method for suppressing myotonia in cerebral palsy.

2) The target sites were the acupuncture and the nerve block points, and the muscles where the myotonia was observed. The myotonic suppression of any sites on the body is possible.

3) The laser irradiation is not effective for regions where irreversible joint contracture occurs.

4) The laser irradiation before the slow stretching training is useful because the pain associated with the stretching is suppressed.

5) The irradiation is completely free from pain or serious adverse reaction.

6) The laser irradiation might act as a trigger for improving the imbalance of the antagonistic muscles.

7) LLLT can be positioned as supplementary treatment for enhancing the effect of functional training.

References

1. Asagai Y, Kanai H, Miura Y, Ohshiro T (1994) Application of low reactive-level laser therapy (LLLT)in the functional training of cerebral palsy patients. Laser Therapy 6: 195-201.
2. Asagai Y, Watanabe Y, Ohshiro T, Yamamoto K (2005) Suppression of myotonia in cerebral palsy and adjunctive effect of low level laser therapy on intensive functional training. Laser Therapy 14: 171-178.
3. Asagai Y, Imakire A, Ohshiro T (2000) Thermographic effects of laser therapy in patients with cerebral palsy. Laser Therapy12: 12-15.
4. Asagai Y, Sujaritpong T, Tranvan L, Ohshiro T (2007) Assessment of changes in carotid blood flow following LLLT of the neck. Laser Therapy 16: 127-132.
5. Maegawa Y, Itoh T, Hosokawa T, Yaegahsi K, Nishi M (2000) Effects of near-infrared low level laser irradiation on microcirculation. Lasers Surg Med 27: 427-437.
6. Asagai Y, Yamamoto K, Ohshiro T (2010) Application of low-level laser therapy to orthopedic diseases and evaluation of its optical characteristics. Laser Therapy 19: 79-88.
7. Asagai Y, Watanabe Y, Ohshiro T, Yamamoto K (2005) Suppression of myotonia in cerebral palsy and adjunctive effect of low level laser therapy on intensive functional training. Laser Therapy 14:171-178.
8. Asagai Y, Ueno R, Miura Y, Ohshiro T (1995) Application of low reactive-level laser therapy(LLLT) in patients with cerebral palsy of the adult tension athetosis type. Laser Therapy 7: 113-118.
9. Asagai Y, Yamamoto K, Ohshiro T (2009) Review of patients with Perthes disease responding poorly to near infrared irradiation therapy. Laser Therapy18: 85-96.
10. Asagai Y, Yamamoto K, Ohshiro T (2007) Application of low-level laser therapy (LLLT)for reduction of congenital dislocation of the hip. Laser Therapy16: 75-79.
11. Asagai Y, Yamamoto K, Ohshiro T (2007) Significance of low level laser therapy (LLLT) on acetabular formation and femoral head growth in patients with congenital dislocation of the hip. Laser Therapy16: 207-214.
12. Asagai Y (2014) The effect of LLLT on bone metabolism in children with severe cerebral palsy (a secondary publication). Laser Therapy 23: 243-247.
13. Asagai Y, Yamamoto K, Ohshiro T, Ohshiro T (2012) Bone metabolism in cerebral palsy and the effect of Light-Emitting Diode(LED) irradiation. Laser Therapy 21: 23-31.
14. Asagai Y, Yamamoto K, Ohshiro T, Ohshiro T (2014) Investigation regarding prevention of insufficiency fractures in children with severe cerebral palsy by Light-Emitting Diode(LED) irradiation. Laser Therapy 23: 121-128.