Low Level Laser Therapy for Radial Nerve Palsy Patients : Our Experience

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Background and Aims: Peripheral nerve injury is one of the frequent complaints which is seen in the outpatient clinic of our medical institute. In previous studies we have reported on the benefits of low level laser therapy (LLLT) for central nerve system disorders, namely cerebrovascular accidents and cerebral palsy. The present study is a report on our experience of the effects of LLLT for peripheral nerve palsy.

Materials and Methods: Over the past 5 years, 13 subjects visited the out-patient clinic with the chief complaint of radial nerve palsy caused by compression of the nerve through with abnormal positioning, and sleeping posture at night. The patients were treated with LLLT. A 1000 mW semi-conductor laser device was used, delivering 830 nm in continuous wave at a dose of 20.1 J/cm² /point, and five points were treated per session (*i.e.,* 1 treatment) twice a week for 3 months (total 24 treatments). In 6 patients LLLT was combined with brace therapy.

Results: Modified Daniels' manual muscle testing was used to determine the effects of LLLT for the muscle power of the extensor carpi radialis, and on completing the treatment regimen excellent improvement was observed in 9 cases out of 13. Combination treatment (laser therapy with bracing) resulted in 4 excellent cases out of 6 cases. Discussions with the patients clarified that it was important for them to learn how to avoid the particular posture that could cause them radial nerve palsy in daily life in order to have continuous benefits from the treatment.

Conclusion: The present study demonstrated that LLLT was an effective form of treatment for radial nerve palsy. In addition, patients were advised to avoid any incorrect posture which might induce radial nerve palsy.

Key words: Low Level Laser Therapy • Peripheral nerve injury • Radial nerve palsy • Posture education

Introduction

Since the middle of the 20th century, Low level laser therapy (LLLT) has become popular and has been approved for clinical usage. LLLT with lasers such as the gallium aluminium arsenide (GaAlAs) or in earlier times helium-neon (HeNe), whose wavelengths fall in the waveband between 600 nm-984 nm, is regularly used for a variety of disorders in physical therapy.

LLLT has been shown to affect many cellular processes, although the mechanisms have not been fully defined. In previous studies our group has reported the benefits of LLLT for central nerve system disorders, namely cerebrovascular accidents and cerebral palsy. [1,2] Many authors have additionally reported significant effects of LLLT in acute and chronic painful and paralytic conditions such as rheumatoid arthritis, osteoarthritis, fibromyalgia, and the peripheral nerve neuropathies. [3-7]

Radial nerve palsy, which can result from a complex humerus fracture, direct nerve trauma, compressive neuropathies or neuritis, has been reported widely in the literature, with some controversy regarding its diagnosis and treatment. [8] The appropriate management of any case of radial nerve palsy depends primarily on an accurate determination of its cause, severity, duration and the level of involvement. In this article we report on our ex-

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perience of treating patients with the axonotmesis type of the Seddon classification of t radial nerve palsy.

Subjects and Methods

1: Subjects

Thirteen patients (8 males and 5 females) between the age of 6 and 73 years with an average age of 46.4 yr took part in this study. All subjects were outpatients who visited the rehabilitation department of our hospital between April, 2012 and March, 2017 **(Table 1)**. All patients visited the out-patient clinic within one week after onset of the complaint. They all had a definitive diagnosis of radial nerve palsy (axonotmesis type according to the Seddon classification, without surgical indication **Table 2**). Diagnosis was based on physical symptoms: complaints caused by trauma, reduced muscle power of the extensor

Table 1: Outline of Cases

case	age	sex	nerve	irradiation time	treatment of number of times	MMT*: ECR**		
						before	after	evaluation#
1	73	M	R-radial	5 min	24 times	1	7	E
2	47	M	L-radial	5	24	2	8	E
3	70	M	L-radial	5	24	1	9	E
4	25	F	R-radial	5	24	1	9	E ***
5	26	M	R-radial	5	24	2	9	E
6	47	M	R-radial	5	24	1	2	N
7	44	F	R-radial	5	24	1	4	F
8	6	M	L-radial	5	24	1	9	E ***
9	48	F	L-radial	5	24	1	9	E ***
10	50	M	L-radial	5	24	1	9	E ***
11	48	F	R-radial	5	24	1	9	E
12	73	F	L-radial	5	24	1	2	N ***
13	46	M	L-radial	5	24	2	5	F ***

*MMT (Manual Muscle Testing): Modified from Daniels' method
**ECR: Extensor Carpi Radialis muscle
***: Bracing
#: Evaluation of ECR' muscle power
- Excellent (E) :7-9
- Good (G) :5-6
- Fair (F) :3-4
- No change (N) :1-2
- Worse/Side effect: ---

Table 2: Seddon Classification (Seddon H: Three types of nerve injury. Brain 66:237•288, 1943:)

Type 1 Neurapraxia: - No anatomical disruption - A nerve interrupted conduction causing temporary paralysis - No axonal degeneration occurs - Typically, there is recovery in days to weeks
Type 2 Axonotmesis - Axonal degeneration but endoneurial tubes and surrounding connective tissue elements remain intact - Distal Wallerian degeneration - Full recovery is usual but may take weeks to months
Type 3 Neurotmesis - Nerve divided - Usually violent, open injuries - All axons and connective tissue elements disrupted - Wallerian degeneration distally - Full recovery unlikely

Table 3: Low Level Laser Therapy Device Specifications

Laser Element	Semiconductor Laser Diode Ga-Al-As: Gallium Aluminium Arsenide
Model	MDL-2001 model
Manufacturer	Matsushita Electric Corporation, Tokyo, Japan
Wavelength	830 ± 15 nm
Output	1000 mW ± 20%
Mode	Continuous wave mode Contact mode with positive pressure
Irradiated area	diameter in 14 mm: actual area in 1.5 cm^2
Irrariation time	30 sec
Energy density	20.1 J/cm^2
Power Supply	100 VAC, 50-60 Hz

carpi radialis muscle, sensory disturbance, positive Tinel's sign, and dropped hand deformity.

2: Methods

We used a 1000 mW semiconductor laser device, the MDL 2001 (Matsushita Electric Corporation, Tokyo, Japan), delivering 830 nm in continuous wave for treatment of the radial nerve palsy patients. Each point was irradiated with a dose of 20.1 J/cm² with an exposure time of 30 s **(Table 3)**. Five points were irradiated **(Figure 1)** per session (comprising 1 treatment) twice a week for 3 months (total 24 treatment sessions). We excluded those patients who had used or were using steroid therapy to ascertain better the effect of the LLLT intervention. In 6 patients LLLT was combined with brace therapy. The study was conducted under the principles of the Declaration of Helsinki (2011). The trial was conducted with the approval of the Ethics Committee of the Toho University School of Medicine, Institutional Review Board (IRB). The purpose and potential outcomes of the trial were explained to all participants, and they gave written informed consent to participate the study.

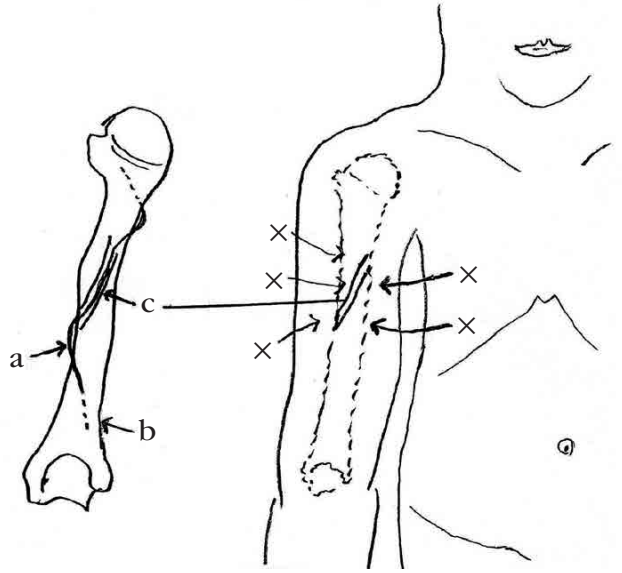

Figure 1: A schematic illustration of the spiral groove of the humerus and the radial nerve (frontal view)
a: radial nerve
b: humerus
c: spiral groove of humerus
×: irradiation-points-

Table 4-a: MMT: Manual Muscle Testing (Daniels' Grading System)

0:	no contraction
1:	slight contraction
2:	completes range of motion with gravity eliminated
3:	completes range of motion against gravity
4:	completes range of motion against gravity with some resistance at end range
5:	completes range of motion against gravity with full resistance at end range

Evaluation of Manual Muscle Testing (MMT) of the extensor carpi radials muscle:

The muscle power was assessed after treatment sessions with an MMT scale **(Table 4-a,b)**. After treatment, the muscle power of the extensor carpi radialis was measured to assess any changes in Daniels' manual muscle testing results.

Lifestyle education for the patients:

In addition to the LLLT sessions, patients were advised to continue their normal living style. We give them written instructions containing specific advice on maintaining a good posture to avoid any trigger positions associated with radial nerve palsy caused by nerve compression through abnormal positioning, and bad sleeping posture at night.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics, version 24, IBM Company. The Wilcoxon signed rank test was applied to comparison of MMT evaluation scores between before and after LLLT. The Mann-Whitney U-test was applied to comparison of increments in the MMT score between the bracing and non-bracing groups. Significance level was set at 0.05.

Results

MMT Evaluation:

The muscle power of the extensor carpi radialis at the first visit and at the final visit are shown in the right-hand

Table 4-b: MMT (Manual Muscle Testing)

Daniels' Method	Modified from Daniels' Method
0	1
1	2
2	3
3-: between 2 and 3	4
3:	5
3+: between 3 and 4	6
4:	7
4+: between 4 and 5	8
5:	9

columns of **Table 1**, together with the classification of efficacy as follows: a score of 7-9, excellent (E); 5-6, good (G); 3-4, fair (F); and 1-2, no change (N). A negative value was used to denote exacerbation of the presence of adverse side effects. Nine cases of the 13 scored E, 0 cases scored G, and 2 each scored F and N. Zero cases showed any adverse events or exacerbation. This showed that LLLT was safe and effective in 69% of our 13 patients. The MMT score after LLLT was significantly higher than the score before LLLT ($p = 0.0015$). No significant difference was detected in the MMT score increment between the bracing and the non-bracing groups ($p = 0.534$).

Patient Lifestyle Guidance:

Patients were advised to avoid any posture which could induce radial nerve palsy by compression, and we advised the patients how to avoid incorrect positions in their Activities of Daily Living (ADL) and bad sleeping posture at night, as already mentioned in the Subjects and Methods section. After discussions with the patients, the lifestyle education was well understood in all cases, and the appropriate advice that was given. However, in the score-sheet filled out by patients after the treatment, there were many cases who did not precisely follow the lifestyle education; therefore, statistical analysis was not performed with regard to this parameter.

Discussion

Peripheral nerve injury is categorized according to the Seddon classification (three types per **Table 2**) based on the extent of damage to the nerve and surrounding connective tissues (endoneurial sheath), as follows. Type 1: Neurapraxia is an injury to a nerve which has interrupted conduction causing temporary paralysis and which is followed by a complete and rapid recovery, although any marked axonal degeneration can be associated with poor results. Type 2: Axonotmesis is axonal nerve damage (Wallerian degeneration) without the surrounding endoneurial sheath being severed. Type 3: Neurotmesis is a crushed peripheral nerve with complete severance of the axon and the endoneurial sheath.

The radial nerve is more commonly injured at a more proximal level on the arm where it spirals around the humerus. Injury at the spiral groove of the humerus is most commonly associated with humerus fracture, plus direct compression may occur with abnormal positioning during the day, and an abnormal sleeping posture.

The authors' investigations have shown that LLLT has a positive influence on nerve regeneration in human subjects. LLLT is widely employed in the treatment of a number of pathological conditions among musculoskeletal disorders including peripheral neuropathies. The fact that treatment of damaged nerves with appropriate LLLT regimens somehow restores poorly functioning or compromised nerves seems to be well accepted. [9] Both experimental and practical clinical evidence has shown that the low incident levels of laser energy at appropriate wavelengths and parameters can have a positive effect on regeneration of injured nerves, which is encouraging in its use. [8, 9].

A growing body of evidence exists that LLLT may stimulate nerve regeneration: this hypothesis was tested in rats, [10, 11] and has facilitated nerve regeneration in the experimental [12] and clinical studies. [9, 11] Many evidence lines have shown that peripheral nerve regeneration may be accelerated by physical agents, such as radiofrequency (RF) treatment, bracing, and ultrasound. LLLT has also been studied with regard to its potential by its positive role in peripheral nerve regeneration [12-16]. However, some authors did not find any nerve conduction change in human beings or animals. [17, 18] This finding points to the importance of the use of appropriate wavelengths, intensities (irradiance or power density) and fluences when treating compromised nerves.

Generally, we treat cases of radial nerve palsy with medication, bracing, education in life style, physical therapy, and surgery in some cases. LLLT is simple and easy to administer without any side effects. Amongst others, Rochkind and Oliveira have reported that the study of peripheral nerve injuries has expanded the understanding of the processes and factors that contribute to nerve regeneration, improvement of biological conduction and the application of LLLT, perhaps in combination with the administration of growth-promoting molecules is proposed. [9, 14, 19] Although the potential mechanism of action may be somewhat speculative, the authors can surely conclude that the well-proven action of near-IR LLLT on the improvement of blood flow and neovascularization of devascularized neural tissue has a strong influence on nerve regeneration.

Conclusion

Our results in the present study confirmed that LLLT was an effective treatment for radial nerve palsy caused by compression with abnormal posture both during activities of daily living, and while sleeping. To obtain the maximum benefit from LLLT intervention, it is important to educate patients, and to reinforce good compliance with all advice given.

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